New Scientist

WEEKLY 25 September 2021

MUSTN'T GRUMBLE
The truth about our everyday aches and pains

ENERGY IN CRISIS
How the UK's problems are just a taste of what's to come

STOP THE ROT
Our food-waste mountain, and how to tackle it

The BLACK HOLE PARADOX

The UNSOLVABLE MYSTERY at the HEART of REALITY

By Paul Davies

COVID HOSPITAL WARNING
Why cases could soar in England despite vaccinations

PLUS MUSHBALLS ON URANUS / **WIRED FOR QUANTUM** / **NEWBORN ALIEN WORLDS** / THE NEW DUNE, REVIEWED

No3353 £6.95 CAN$9.99

Find a balance for your family online

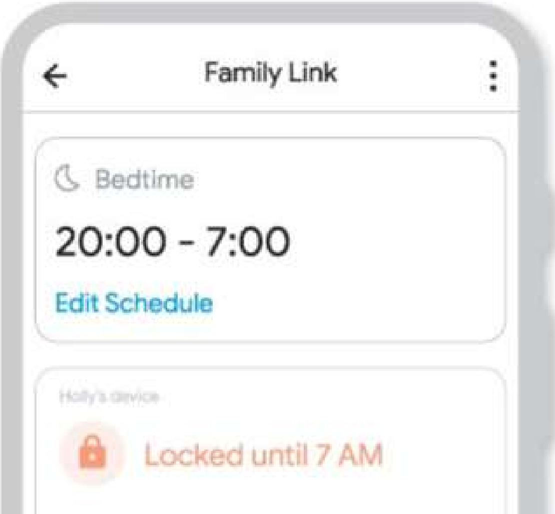
Alison, Holly (12) and Nicky (9)
Derby

Set a bedtime for their device
with the **Google Family Link** app

Google

g.co/familylink

Needs internet connection, Google account + compatible device. App review and approval functionality only available for Google Play apps. Graphics simplified.



Family Link

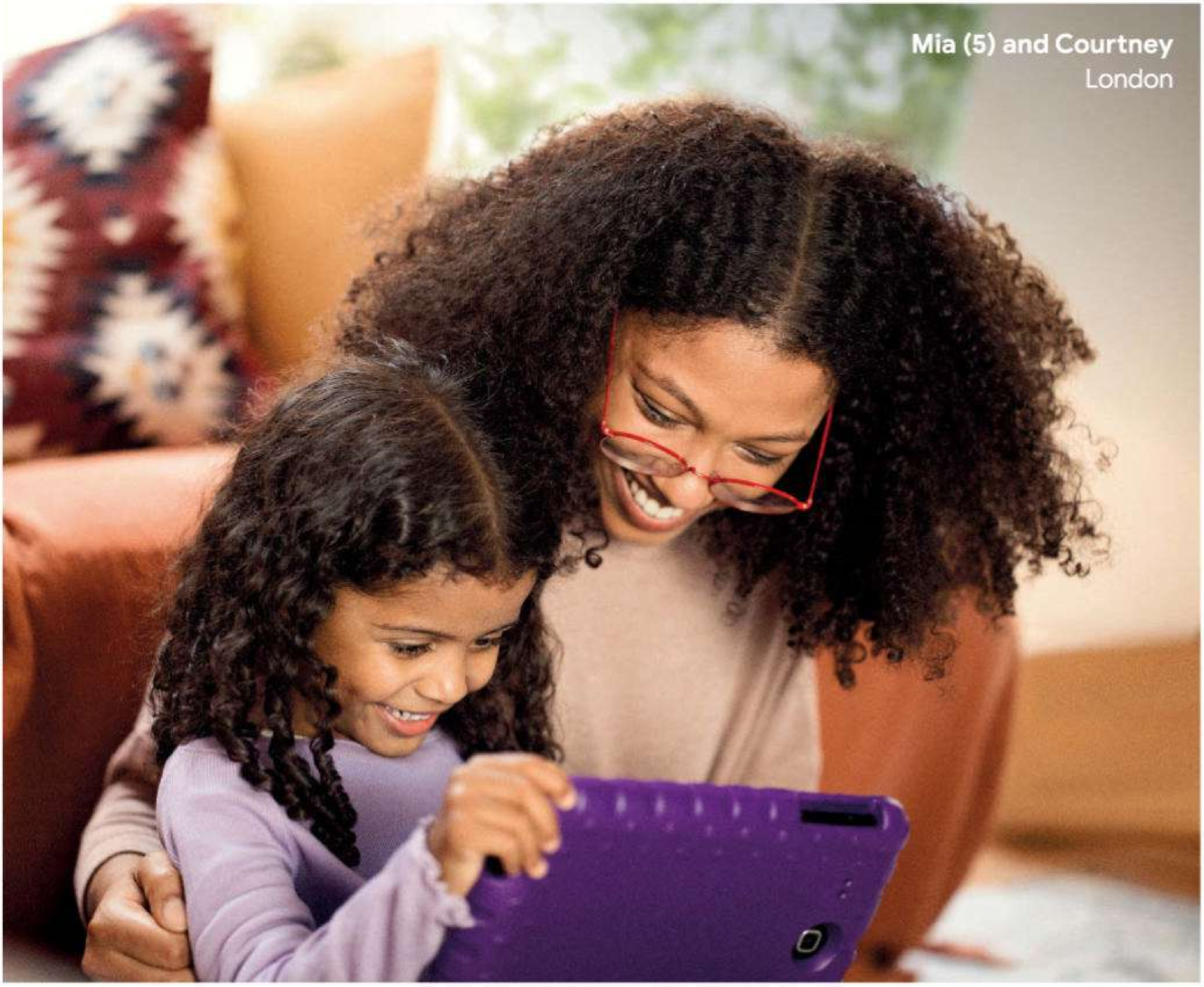
Bedtime

20:00 - 7:00

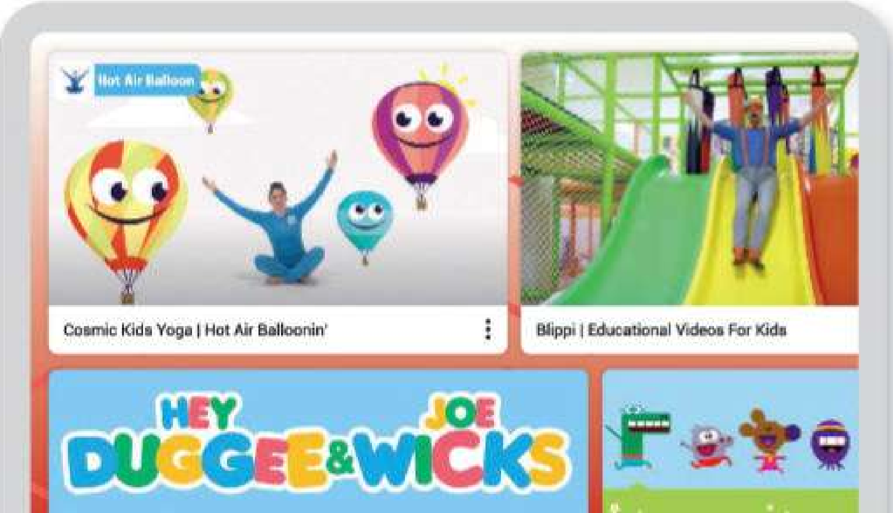
Edit Schedule

Holly's device

Locked until 7 AM



Choose content settings by
age with **YouTube Kids**


Hot Air Balloon
Cosmic Kids Yoga | Hot Air Balloonin'
Blippi | Educational Videos For Kids
HEY DUGGEE & JOE WICKS

YouTube Kids

youtube.com/kids

Simplified representation of YouTube Kids product.
Parent setup required.

FareShare had the power to do more

"Barclays helped us provide more than 5 million meals to families in need"

To find out more about the impact in your area search **'Barclays £100m COVID-19 Community Aid Package'.**

BARCLAYS

FareShare is a registered charity (1100051)

This week's issue

On the cover

34 The black hole paradox
The unsolvable mystery at the heart of reality
By Paul Davies

10 Covid hospital warning
Why cases could soar in England despite vaccinations

New Scientist

The BLACK HOLE PARADOX

COVID HOSPITAL WARNING

Vol 251 No 3353
Cover image: Andy Gilmore

38 Mustn't grumble
The truth about our everyday aches and pains

7 Energy in crisis
How the UK's problems are just a taste of what's to come

42 Stop the rot
Our food-waste mountain, and how to tackle it

12 Mushballs on Uranus
17 Wired for quantum
14 Newborn alien worlds
30 The new *Dune*, reviewed

38 Features

> "Women have a stronger antiviral immune response, which may be why men tend to get sicker"

News

12 Bad odour
Woman who gained sense of smell as an adult doesn't like it

16 Off target
The world is falling short of climate change goals

19 Appetite for fish
The global demand for seafood is expected to double by 2050

Views

23 Comment
Plans to change how drugs are assessed mustn't affect safety precautions, says Clare Wilson

24 The columnist
Graham Lawton on the mental toll of climate change

26 Aperture
Astronomy Photographer of the Year winners

28 Letters
Uncertainties on the journey to a net-zero life

30 Culture
Denis Villeneuve's take on *Dune*

SPACEX

13 Splashdown Tensions over public access to private space missions

Features

34 Disappearing trick
Black holes seem to eat information – an impossible act that science just can't explain

38 What doesn't kill you...?
The odd sniffle used to be no biggie. But it's time we paid attention to minor ailments

42 Fighting food waste
This is one environmental crisis we know how to tackle

The back pages

51 The science of cooking
Sous vide steak in a beer cooler

53 Puzzles
Try our crossword, quick quiz and logic puzzle

54 *Almost* the last word
Does talking or singing to plants help them grow?

56 Feedback
Unusual units, from Sydney Harbour to hippopotami

56 Twisteddoodles for New Scientist
Picturing the lighter side of life

Elsewhere on New Scientist

Academy

Consciousness: the world's deepest mystery

Great minds have struggled to understand consciousness for centuries. Now, we are finally inching towards an explanation, which makes this the perfect time to take our new neuroscience course that looks at how the human brain conjures up our unique subjective experiences. Register your interest or sign up online.

academy.newscientist.com

Event

Creating a sustainable future

Join us on 25 September for a superb one-day online event about the greatest existential challenge we face: climate change. Hear what we must do to create a sustainable future and learn about the science and technology needed to enable those shifts.

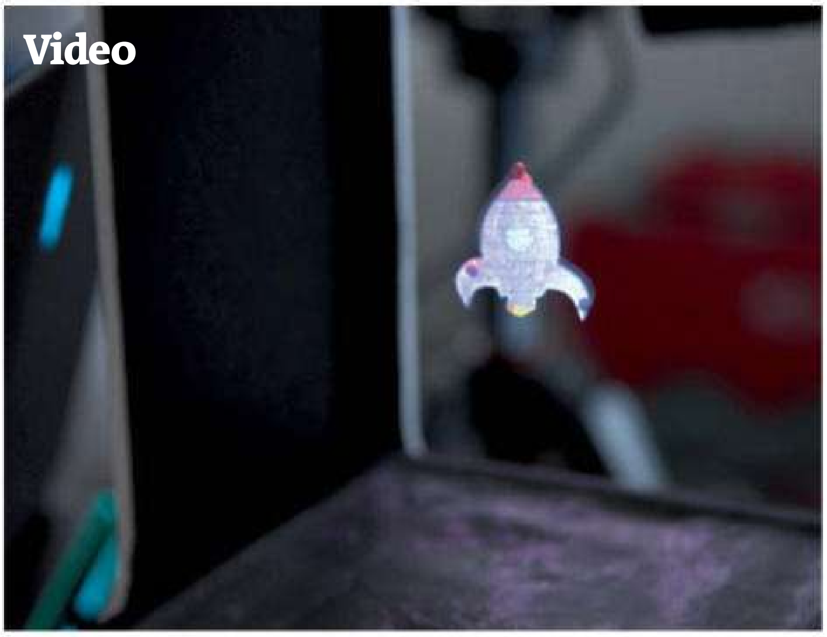
newscientist.com/ns-events

Podcast

Weekly

In some parts of the world, taking a stand for the planet can be dangerous. Laura Furones at campaign group Global Witness tells us about the 227 environmental activists who were murdered in 2020. Plus: an effort worth $15 million is afoot to bring back mammoths, but there are serious ethical issues to consider; and the team learn that cows are easier to potty-train than toddlers.

newscientist.com/nspod



DAVID STOCK

Suspended in sound How to acoustically levitate all manner of objects

SCIENCE PICTURE CO/ALAMY

Mammoth in the room The highly fraught ethics of de-extinction

Video

Sonic tractor beams

Levitating objects with sound has long been a fun trick. But now this technology has some impressive and potentially life-saving new uses. Our latest video looks at how sonic tractor beams can be used to make holographic displays and to treat kidney stones. Don't forget to subscribe to our channel for more videos.

youtube.com/newscientist

Newsletter

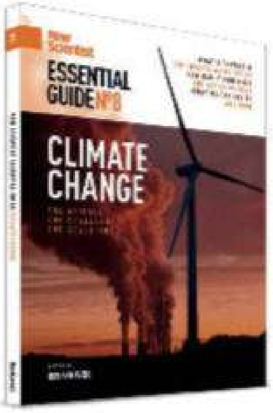
Our Human Story

Sign up for Michael Marshall's delightful newsletter on human evolution, delivered free to your inbox each month. In the latest edition, Michael looks at the deceptively difficult question of how and when humans first migrated into the Americas.

newscientist.com/sign-up/our-human-story

Newsletter

> **"By 40,000 years ago, people were established in Africa, Eurasia and Australia – but the Americas took a bit longer"**



Essential guide

Climate change is the greatest challenge of our age. The eighth *New Scientist Essential Guide* is a one-stop shop for information on the basic science of climate change, the history of efforts to combat it and the technologies that will help us stop it.

shop.newscientist.com

**KEYSTONE
POSITIVE
CHANGE
INVESTMENT
TRUST**

A change of name. A change of strategy.

It's all positive.

Baillie Gifford has been appointed by the board of **Keystone Investment Trust** as the company's new investment manager. The newly named **Keystone Positive Change Investment Trust** sees the team behind the award-winning **Positive Change Fund** take the Trust in a new exciting direction. The result is a Trust that can invest in both public and private companies that it believes can deliver on the strategy's dual objectives: to make a positive impact on the planet; and on investors' returns.

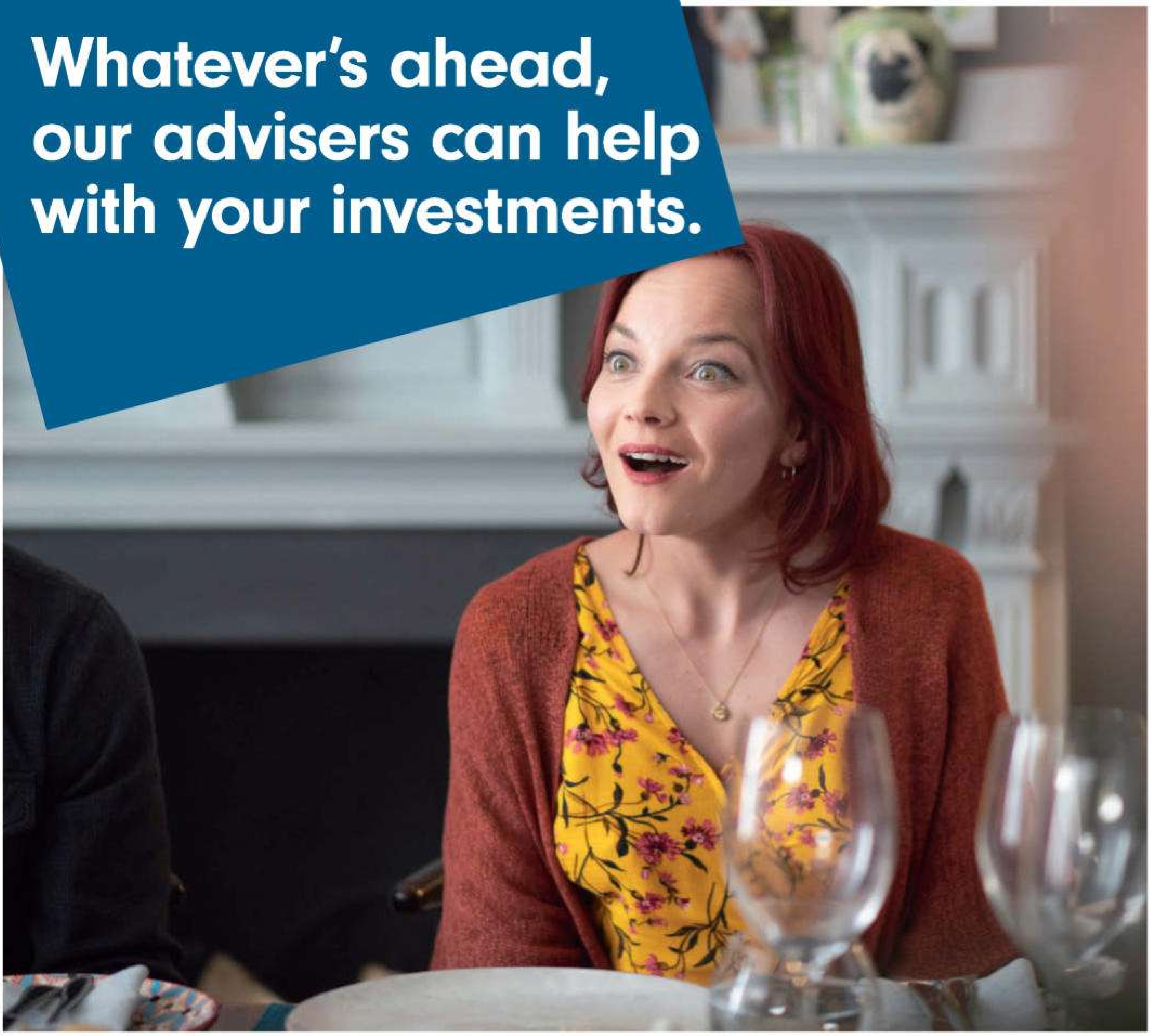
Please remember that changing stock market conditions and currency exchange rates will affect the value of the investment in the fund and any income from it. Investors may not get back the amount invested.

Find out more at keystonepositivechange.com
A Key Information Document is available. Call 0800 917 2112.

BAILLIE GIFFORD | *Actual Investors*

Your call may be recorded for training or monitoring purposes. Issued and approved by Baillie Gifford & Co Limited, whose registered address is at Calton Square, 1 Greenside Row, Edinburgh, EH1 3AN, United Kingdom. Baillie Gifford & Co Limited is the authorised Alternative Investment Fund Manager and Company Secretary of the Trust. Baillie Gifford & Co Limited is authorised and regulated by the Financial Conduct Authority (FCA). The investment trusts managed by Baillie Gifford & Co Limited are listed UK companies and are not authorised and regulated by the Financial Conduct Authority.

Whatever's ahead, our advisers can help with your investments.



Life happens, and when it does, Fidelity's advisers are here to help. They'll listen and flex their advice to you, including:

- ongoing or one-off support with managing your investments
- saving and planning for retirement
- investing an inheritance or other lump sums

Whatever your needs are... it all starts with a conversation.

Important information: Terms apply. Please remember that the value of investments can go down as well as up, so you may get back less than you invested.

For a free, no obligation discussion, call us on **0800 358 1488** or visit **fidelity.co.uk/advice**

ISAs | Pensions | Funds | Shares | Advice

People love us ★★★★★ Trustpilot

Fidelity INTERNATIONAL

Issued by Financial Administration Services Limited, authorised and regulated by the Financial Conduct Authority. Fidelity, Fidelity International, the Fidelity International logo and F symbol are trademarks of FIL Limited. Trustpilot rating based on 2,085 reviews as at 24.08.21. UKM0821/36526/CSO10565/0822 B.

Time to look beyond gas

The UK's crisis shows the folly of a global dash for a supposedly clean fuel

MANY critiques of the UK's unfolding gas supply crisis have focused on the peculiarities of how its energy market is regulated (see page 15). But that is to ignore the global scope of this crisis. In Europe, for example, gas prices are up 170 per cent since this January.

The UK is particularly vulnerable to gas volatility due to its "dash for gas" to replace coal for electricity generation since the 1990s. That was largely driven by economics, with a happy by-product of reducing carbon emissions.

Now countries the world over are attempting to replicate it. In 2019, demand for gas rose more than any other energy source. It is forecast to be up strongly this year and to keep growing until 2024.

Gas advocates like to push the fuel as a "bridge" to transition the world from fossil fuels to renewable energy. Even if it weren't for the gas industry's manifold failings, from continued leaks to huge flaring emissions, it would be a distinctly ropey bridge. A path to net-zero emissions by mid-century needs deeper cuts than gas can deliver. Even the conservative International Energy Agency says there can be no new gas fields in a net-zero world.

> "Fossil fuels are not a stable, economically viable solution for our future energy needs"

Yet many still argue that more fossil fuels are the answer. If only Russia would stop limiting its gas supplies to Europe, say some. Others call on the UK to exploit its shale gas reserves.

Here's news for them: last year, 62 per cent of electricity from new renewables projects was more affordable than the cheapest low-cost fossil fuel option. That figure will only increase as wind and solar technologies mature still further. Meanwhile, volatile fossil fuel prices were the main reason Norway's central bank advised the country's sovereign wealth fund to ditch oil and gas.

The gas crisis should be taken for what it is: cutting the last support to the idea that fossil fuels in any shape provide a stable, economically viable solution to satisfying our future energy needs. The way forward is clear: accelerated investment in energy efficiency, low-carbon heating and renewable electricity generation and grid and storage technologies. The UK – and the world – needs to hear that message, and act on it. ▮

PUBLISHING & COMMERCIAL

Commercial and events director Adrian Newton
Display advertising
Tel +44 (0)20 7611 1291 **Email** displayads@newscientist.com
Sales director Justin Viljoen
Recruitment advertising
Tel +44 (0)20 7611 1204 **Email** nssales@newscientist.com
Recruitment sales manager Viren Vadgama
Key account manager Deepak Wagjiani
New Scientist Events
Tel +44 (0)20 7611 1245 **Email** live@newscientist.com
Sales director Jacqui McCarron
Event manager Henry Gomm
Marketing manager Emiley Partington
Events team support manager Rose Garton
Events and projects executive Georgia Peart
New Scientist Discovery Tours
Director Kevin Currie
Marketing
Marketing director Jo Adams
Head of campaign marketing James Nicholson
Head of customer experience Emma Robinson
Email/CRM manager Rose Broomes
Digital marketing manager Craig Walker
Customer experience marketing manager Esha Bhabuta
Marketing executive Amelia Parmiter
Marketing assistant Charlotte Weeks
Digital & Data
Digital product development director Laurence Taylor
Head of audience data Rachael Dunderdale
Head of learning experience Finola Lang
Business intelligence analyst Michael Prosser
Technology
CTO and programme director Debora Brooksbank-Taylor
Head of technology Tom McQuillan
Maria Moreno Garrido, Dan Pudsey, Amardeep Sian,
Ben Townsend, Piotr Walków

NewScientist

Chief executive Nina Wright
Executive assistant Lorraine Lodge
Finance & operations
Chief financial officer Amee Dixon
Financial controller Taryn Skorjenko
Management Accountant Alfred Princewill
Facilities manager Ricci Welch
Human resources
Human resources director Shirley Spencer
HR business partner Katy Le Poidevin

CONTACT US

newscientist.com/contact
General & media enquiries
UK **Tel**+44 (0)20 7611 1200
Northcliffe House, 2 Derry Street, London, W8 5TT
Australia 58 Gipps Street, Collingwood, Victoria 3066
US PO Box 80247, Portland, OR 97280
UK Newsstand
Marketforce UK Ltd **Tel** +44 (0)33 0390 6555
Syndication
Tribune Content Agency **Tel** +44 (0)20 7588 7588
Email tca-articlesales@tribpub.com
Subscriptions
newscientist.com/subscription
One year print subscription (51 issues) UK £198
Tel +44 (0)330 333 9470
Email subscriptions@newscientist.com
Post New Scientist, Rockwood House, Perrymount Road,
Haywards Heath, West Sussex RH16 3DH

© 2021 New Scientist Ltd, England.
New Scientist is published weekly by New Scientist Ltd. ISSN 0262 4079. New Scientist (Online) ISSN 2059 5387. Registered at the Post Office as a newspaper and printed in England by Precision Colour Printing Ltd

EDITORIAL

Editor Emily Wilson
Executive editor Richard Webb
Creative director Craig Mackie
News
News editor Penny Sarchet
Editors Jacob Aron, Chelsea Whyte
Reporters (UK) Jessica Hamzelou, Michael Le Page,
Matthew Sparkes, Adam Vaughan, Clare Wilson
(US) Leah Crane, (Aus) Alice Klein
Trainee Jason Murugesu
Intern Krista Charles
Digital
Digital editor Conrad Quilty-Harper
Podcast editor Rowan Hooper
Web team Emily Bates, Matt Hambly,
Alexander McNamara, David Stock, Sam Wong
Features
Head of features Catherine de Lange
and Tiffany O'Callaghan
Editors Abigail Beall, Daniel Cossins, Anna Demming,
Kate Douglas, Alison George, Joshua Howgego
Feature writer Graham Lawton
Culture and Community
Comment and culture editor Timothy Revell
Liz Else
Subeditors
Chief subeditor Eleanor Parsons
Bethan Ackerley, Tom Campbell,
Chris Simms, Jon White
Design
Art editor Julia Lee
Joe Hetzel, Ryan Wills
Picture desk
Picture editor Helen Benians
Tim Boddy
Production
Production manager Joanne Keogh
Robin Burton

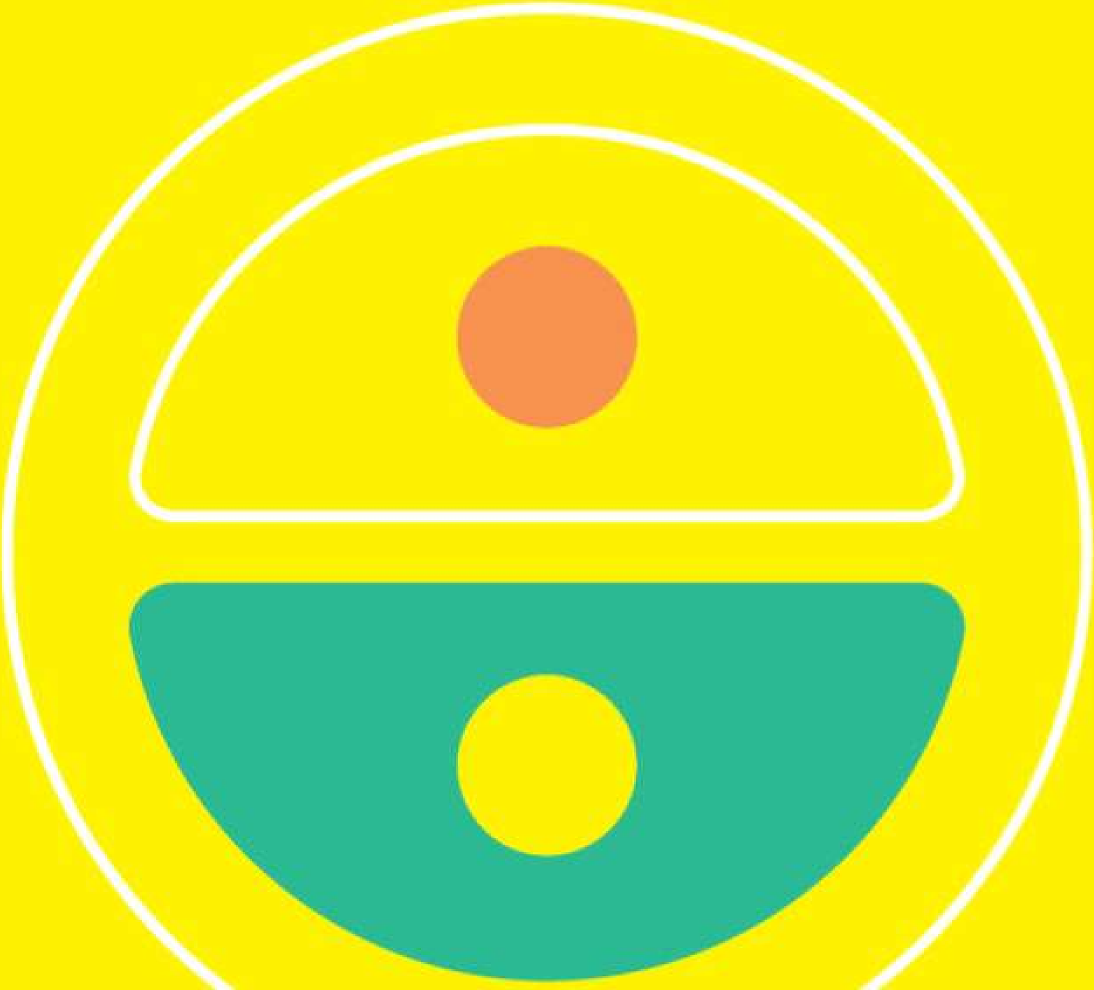
cytiva

Accelerating the path to new cell and gene therapies

Learn more at
cytiva.com

Cytiva and the Drop logo are trademarks of Life Sciences IP Holdings Corporation or an affiliate.
©2021 Cytiva
For local office contact information, visit cytiva.com/contact

CY24114-03Sep21-AD



Hello Mercury
BepiColombo spacecraft will fly by smallest planet **p13**

Unclear skies
UK could be worst hit by views of satellite constellations **p15**

No thank mew
Cats turn up nose at objects that smell like owners **p17**

Red Planet weather
A hundred dust devils pass over Mars rover **p18**

False politicians
Fears fake TikTok users will influence German election **p19**

SEAN GALLUP/GETTY IMAGES

Traffic on the A100 ring road near Berlin, Germany

Environment

Call for cleaner air

The World Health Organization has strict new air pollution limits, but it remains to be seen if countries adopt them, says **Adam Vaughan**

MILLIONS of deaths could be avoided if the world adopts tough new air pollution limits set out this week by the World Health Organization (WHO).

The guidelines call for much lower daily and annual levels of exposure to six pollutants from cars, power stations and other sources, in the first major overhaul of the recommendations in 16 years. The stricter ceilings are due to an increase in research on the health impacts from even low levels of pollution.

"We have even stronger evidence than before on the effect of air pollution on health. Before our evidence was huge, now it's even stronger," says Maria Neira at the WHO.

Stephen Holgate at the University of Southampton, UK, says population-based studies have shown "there are no safe levels of air pollution".

The WHO's air quality guidance isn't legally binding but influences governments, and clean air campaigners have increasingly been calling for stricter measures.

Under the new advice, annual limits on people's exposure to tiny particulate matter known as PM2.5, which mostly comes from burning fossil fuels in cars and industry, are halved. Annual exposure to nitrogen dioxide, a toxic gas from diesel vehicles, is cut by 75 per cent.

Air pollution is currently the world's greatest environmental threat to health, resulting in 7 million premature deaths a year, according to the WHO, although some estimates are even higher.

The WHO calculates that if the world met the new PM2.5 limits, ignoring other measures, it would cut deaths due to PM2.5 by about 80 per cent, or 3.3 million people a year. "How can you refuse to reduce by 80 per cent?" says Neira.

> "We need to view air pollution much more seriously, as it is a major public health problem"

Air quality experts say the new limits are in line with the science on the health impact of exposure to dirty air. "These are really quite significant developments. It's very dramatic. But it does reflect the current state of the literature," says Jonathan Grigg at Queen Mary University of London.

"Harms to health occur throughout the entire life course, but pregnancy and childhood are especially vulnerable periods, with mounting evidence for effects on long-term growth and cognitive ability," says Frank Kelly at Imperial College London. "We need to view air pollution much more seriously, as it is a major public health problem." Meeting the new guidelines is feasible but will be a challenge, especially in many UK cities, he adds.

Grigg says the UK government should consider immediately adopting the new guidelines, using the Environment Bill moving through parliament. "We could lead the world," he says.

A spokesperson for the UK Department for Environment, Food & Rural Affairs says: "We will consider the updated WHO guidelines on PM2.5 to inform the development of air quality targets, but we must not underestimate the challenges these would bring, particularly in large cities and for people's daily lives."

Globally, 91 per cent of the world's population lives in areas that exceed the old limits. Asia has a particularly high death toll linked to dirty air, with people in cities across China and India breathing some of the highest levels of particulate pollution.

Because of the difficulty of making such big air pollution cuts, the WHO has also published easier interim targets. Neira says countries should remember that cleaning up their air will not only save lives, but protect against future respiratory diseases and help meet climate goals. ▮

Analysis **Coronavirus**

How many hospitalisations?

England could soon see up to 7000 covid-19 hospitalisations a day, but that is only one of several different possible scenarios, reports **Clare Wilson**

MARK THOMAS/ALAMY

An arrival at the Royal London Hospital earlier this month

PEOPLE in England who thought the pandemic was all but over had a rude awakening last week. A government scientific advisory committee said that the number of people in England admitted to hospital with the coronavirus could rise to between 2000 and 7000 a day over the next few months. That compares with just under 1000 a day presently, and a little over 4000 at the height of the second wave in January. Given that so many people have now been vaccinated against covid-19 and case numbers have recently been declining, why are predictions for winter in England so bleak?

One factor that can get overlooked is that even in places with good vaccine uptake, like the UK and parts of the US and Europe, vaccines don't provide complete protection. There will always be three main groups who are vulnerable: those who aren't being immunised, which at this stage in the UK mostly comprises children; those who refuse jabs; and those who have had the vaccine but it fails to protect them.

"People forget about that, but no one ever said the vaccine was going to be 100 per cent effective," says Simon Clarke at the University of Reading, UK.

Because of these groups, modellers predicted earlier this year that as countries such as the UK emerged from lockdowns, they would see an "exit wave", as increased mixing allowed the virus to spread.

There are signs that the UK may have recently started the downward slope of such a wave. However, its trajectory was complicated by a spike in cases in July, which seems to have been triggered by people gathering inside to watch the European Football Championship.

"If you shave that off, the situation is not that complicated," says Mark Woolhouse at the University of Edinburgh, UK. "There was a rise in cases steadily over the summer that's come to some sort of peak or plateau – that's what a wave looks like."

The football tournament-related spike aside, the wave has so far been lower in height than most models predicted. This is probably because people didn't respond to the end of lockdowns by returning to their old levels of social mixing, the SPI-M-O committee, which advises the UK government, said in its report, which was made public last week. "The population has not reduced their cautious behaviours as dramatically as was considered possible," it said.

7000

Predicted daily covid-19 hospitalisations in England if each infection ends up causing 1.5 more

2000

Predicted daily covid-19 hospitalisations in England if each infection ends up causing 1.1 more

930

Number of people admitted to hospital with covid-19 in England on 14 September

An ongoing study of behaviour by the London School of Hygiene & Tropical Medicine, called the CoMix Social Contact Survey, found that in the week ending 6 September, UK adults were having contact with an average of three people a day, compared with about 11 before the pandemic. And there is often less exposure during such contacts, for instance because people avoid shaking hands and opt to meet outdoors.

But old patterns of behaviour are returning. The survey shows that, while three-quarters of people still wear face masks, their use has been slowly declining since July.

"Over the summer, people were being quite cautious," says Anne Johnson at University College London. "Now people are increasingly going back to work using public transport. We start moving indoors, where we tend to be closer together in unventilated spaces."

This higher level of mixing could trigger a further exit wave, but opposing forces are at play. Factors pushing the infection rate down include a rising number of people with strong immunity to the virus, from infection, vaccination and booster jabs. But it is possible that immunity waning over time and the emergence of more infectious coronavirus variants could push rates up. Everything hinges on how these competing forces balance out, says Johnson. "There's immense uncertainty."

Following July's spike, the pressures pushing infection rates up and down in England have been roughly equal, with R – the number of new infections triggered by each case – close to 1. It may not take much to nudge R back above 1 again though, and if a factor like waning immunity causes it to hit 1.5, it could lead to 7000 hospitalisations a day. But the committee didn't say this would definitely happen – only that it is a possibility. A scenario in which R hits 1.1 and leads to 2000 hospitalisations a day is more likely, according to the group's modelling.

"You could make a strong case that from now on, you expect the number of cases to go up or to go down or to stay the same," says Woolhouse. "That means you have to be prepared for a set of eventualities. You could encapsulate them as: hope for the best, but prepare for the worst." ▮

Computing

Quantum computer helps design a better quantum computer

Matthew Sparkes

A QUANTUM computer has been used to design an improved quantum bit, or qubit, that could power the next generation of quantum computers. Using the new qubit, it should be possible to build quantum computers that are smaller, higher-performance and more reliable.

As classical computer chips became more complex, it quickly became impractical to design them manually. For decades, it has instead been commonplace to use computers themselves to help optimise new chip designs for the next generation of computers.

But it is unfeasible to simulate the operation of all but the simplest quantum processor inside a classical computer. This is because the computing resources required grow exponentially as each new qubit is added.

Now, Chao-Yang Lu at the University of Science and Technology of China and his colleagues have used a quantum algorithm to run the simulations.

So far, the research has led to the development of a new type of qubit, the quantum version of a classical bit, which can exist in a mixture of a 0 and 1 state until it is measured and settles on one.

The new qubit, dubbed a plasonium, is smaller, less noisy and able to retain its state longer than the group's current qubit design. The team believes that the work opens the way to designing advanced quantum processors using existing quantum machines.

Peter Knight at Imperial College London says the concept is intriguing and also intuitive. "If you think about a classical machine that's trying to simulate a quantum processor, it's hard work. So it's obvious that once you've got a quantum processor, you'd see if you can use it for that purpose. Already it's given them some new insights."

Knight says that the new qubit design offers advantages but also, crucially, reduces several inconvenient features of current generation circuits.

To invent the plasonium, the team used an algorithm called a variational quantum eigensolver, which is often used in quantum chemistry to calculate the energy levels of molecules. This allowed the group to simulate the behaviour of particles in quantum circuits and iron out negative properties while developing positive features, all while avoiding the laborious process of building vast numbers of physical prototypes (arxiv.org/abs/2109.00994).

> **"It's obvious that once you've got a quantum processor, you'd see if you can use it for that purpose"**

The plasonium qubits are each only 240 micrometres long, which is just 40 per cent of the size of the team's current generation qubit design, called a transmon. This means that replacing transmon qubits with plasonium qubits will allow today's large processors to be miniaturised. This will be key because future quantum computers will need to scale up from containing dozens of qubits, as most do today, to having the millions or billions required to carry out useful tasks.

Reducing "noise" in quantum computers is another vital hurdle between current machines and more powerful, useful quantum computers. Crucially, the plasonium is also less noisy than the group's existing transmon qubit. In a classical computer, noise can come from a "bit flip" when a single bit encounters an error, generally caused by interaction with a stray charged particle passing through the computer. It is possible to reduce this problem in the design stage of a classical bit, but designing out similar noise issues in a quantum bit has been challenging. The new approach makes it easier. ■

Animal behaviour

Cuttlefish seen gathering to migrate and defend others

THE cuttlefish has a reputation for being a rather solitary cephalopod. But new footage reveals that groups of wild cuttlefish form shoals to migrate, suggesting they are more social than we thought.

Grouping is common across the animal kingdom, providing a range of benefits including help with foraging, fending off predators and meeting to mate. In cephalopods, the behaviour is mostly associated with squids, which form schools of thousands. Like octopuses, cuttlefish mostly prefer to explore the world on their own, and sightings of social behaviour among them are rare.

Christian Drerup at the University of Cambridge and Gavan Cooke at The Cephalopod Citizen Science Project have collected a series of reports, photos and videos from scuba divers in waters off the south coast of the UK that show 10 examples of shoaling in European cuttlefish (*Sepia officinalis*).

In the videos, cuttlefish could be seen travelling together in a series of formations, some in groups as large as 30 (*Ethology*, doi.org/gwd8).

Sometimes, they formed a horizontal line, with one cuttlefish facing the other direction – possibly acting as a guard while the others slept. At other times, the cuttlefish made a spherical shape, facing outwards in all directions like an ancient Roman army testudo formation. Occasionally, the cuttlefish drifted apart before returning to a group structure.

CHARLES STIRLING (DIVING)/ALAMY

Cuttlefish are usually solitary, but videos have shown they find safety in numbers

The observations were made between 2013 and 2020 during August to September, when these cuttlefish start migrating from their nursery grounds in shallow coastal waters towards deeper waters in the English Channel and off the northern coast of France.

"Shoaling allows for selfish herd defence," says Cooke, providing safety in numbers against a range of predators along the journey. It also probably improves navigation, and may offer an opportunity for social learning. ■

Richard Kemeny

Health

Woman who first gained sense of smell at 24 reports finding it disturbing

Alice Klein

A WOMAN who was born without the brain regions required for smell has mysteriously started smelling things for the first time in her twenties and finds it highly unpleasant.

The woman was diagnosed with congenital anosmia – the inability to smell – at the age of 13. Brain imaging revealed she was missing the olfactory bulbs in her forebrain that detect odour information from the nose and transmit it to other parts of the brain involved in smell perception.

Then, when she was 24, she had an unexpected smell awakening. She began noticing scents like lavender, garlic and manure, with a new smell experience occurring every few weeks. The woman reported feeling disturbed by her new sense, and the fact that she disliked almost all the new smells she encountered increased her anxiety. On one occasion, she felt so overwhelmed she fainted.

A group of smell specialists at the University of Dresden Medical School in Germany conducted tests to try to understand how she had learned to smell.

They presented her with 32 scents and found she could smell half of them. She could detect orange, mint, smoke, turpentine, ginger and lilac, for example, but not coconut, banana, leather, liquorice or cocoa. "It's not like she only smells food-related things or bad odours, it's all over the place," says Thomas Hummel, one of the Dresden specialists.

Next, they monitored her brain activity when she sniffed rotten egg gas and rose perfume using electroencephalography (EEG). This confirmed that her brain was responding to the odours.

A woman smelling perfume from a bottle (model photo)

MASKOT/GETTY IMAGES

But brain imaging showed she still had no olfactory bulbs, leaving her medical team puzzled (*Neurocase*, doi.org/gwmz).

A 2019 study by researchers at the Weizmann Institute of Science in Israel described five women who could smell normally despite having no olfactory bulbs, suggesting the brain can find alternative ways to smell in rare cases.

"But the scientific community has been kind of silent on this because no one can explain how," says Hummel.

The German woman's case is even more bizarre since she only developed the ability to smell in adulthood.

Her brain may have created an alternative pathway for smelling that didn't require the olfactory bulbs and was somehow suppressed by her hormonal status until she became older, says Robert Pellegrino at the Monell Chemical Senses Center in Philadelphia, who has also been involved in her case.

The reason the woman dislikes her new sense may be because we need to develop positive associations with scents in early life to find them pleasant, says Hummel. For instance, many people like the smell of fir trees because they learned to associate it with Christmas at a young age, he says.

Deaf people also sometimes dislike the first sensation of hearing when they receive cochlear implants because it is so unfamiliar, he says.

The woman is currently undergoing odour exposure training to help her adjust to her new smelly world. She has already learned to enjoy some aromas like curry by associating them with pleasant experiences like eating.

Her case highlights the plasticity of the brain and hints that other people born without olfactory bulbs may also be able to learn to smell with appropriate training, says Hummel. "Our brain is a miraculous thing – it's always full of surprises," he says.

Planetary science

Mushballs in the atmospheres of the ice giants

URANUS and Neptune may be hiding slushy hailstones called mushballs deep inside them. These huge clumps of water and ammonia may explain why there is so little ammonia higher up in the ice giants' atmospheres.

Compared with Jupiter and Saturn, which are the other giant planets in our solar system, Uranus and Neptune seem to contain surprisingly little ammonia – based on measurements of other compounds, all of these planets ought to have about the same amount of it. Either Uranus and Neptune formed in some sort of unusual process that included less ammonia in the first place, or something is hiding it.

Recent observations from NASA's Juno spacecraft have shown that Jupiter's ammonia is buried much deeper inside the planet than expected. Tristan Guillot at the Observatory of Nice in France calculated that the same may be true on Uranus and Neptune, thanks to mushballs.

"These particles that can reach a kilogram and can zoom through Jupiter's clouds are able to transport the ammonia and the water down into the deep reaches of the atmosphere," said Guillot when he presented the work at a virtual meeting of the Europlanet Science Congress on 16 September. "Thermodynamics tell us that mushball formation should be more efficient in Uranus and Neptune."

"Uranus and Neptune are critical links to help us understand atmospheres of giant planets"

Both planets are colder than Jupiter, so clumps of liquid ammonia and water are more likely to form ice shells and become slushy, turning into mushballs. They are then expected to fall like hail deep into the atmosphere, where they are hidden beneath thick clouds and we cannot detect them with ground-based telescopes, said Guillot.

"We really need to go there, not only for the mushballs," said Guillot. Uranus and Neptune are critical links to help us understand the diversity of atmospheres that can arise on giant planets, he says.

Leah Crane

Space exploration

BepiColombo probe prepares for its first fly-by of Mercury

Will Gater

THE European and Japanese mission BepiColombo will make a fly-by of the solar system's innermost world on 1 October, diving to just 200 kilometres above the surface of sun-scorched Mercury.

This will be the first of six fly-bys, which will lower BepiColombo's speed and help set up the spacecraft for getting into orbit around the planet in December 2025.

"To be able to see our target up close for the first time during the [October] fly-by will be really special," says Emma Bunce at the University of Leicester, UK, who is principal investigator of the Mercury Imaging X-ray Spectrometer instrument on BepiColombo.

BepiColombo's main cameras – which will be used for imaging from orbit – won't be able to photograph Mercury during the fly-by, because they will be blocked by part of the spacecraft. But the mission also carries "monitoring" cameras for keeping tabs on BepiColombo itself, which will capture images of the planet.

Eleven instruments will gather data during the fly-by, measuring Mercury's magnetic field and the tenuous veil of material surrounding the planet, known as an exosphere. The mission will also attempt to detect dust particles as it swoops by, which could tell us about material being blasted off the surface by impacting meteoroids. These would be the first ever measurements of dust near Mercury, says Joe Zender, the BepiColombo deputy project scientist at the European Space Agency.

Following October's fly-by, BepiColombo's next close encounter with Mercury will be in June 2022. Once in orbit, the mission will split into two spacecraft that will conduct an investigation of the magnetic fields enveloping the tiny world, and of the planet's composition and geological history. ▮

Analysis Commercial space flight

Fewer eyes on the sky

As space tourism takes off, it is no surprise that we see far less of private trips than we did of the journeys of government astronauts, says **Leah Crane**

SPACEX

The first all-amateur crew aboard SpaceX's Dragon spacecraft

ON 18 September, the Dragon spacecraft carrying SpaceX's Inspiration4 mission splashed down safely in the Atlantic Ocean after three days in orbit. None of the four passengers aboard the flight – which was paid for by billionaire Jared Isaacman – was a government-trained astronaut, a first in the history of orbital space flight. By all accounts, the flight was a resounding success, but some have lamented that, unlike with most NASA missions, very little of it was broadcast live.

During the radio silence, some observers pointed to the fact that Netflix is due to release a documentary with footage from the mission, which may limit what could be broadcast live. After landing, Isaacman tweeted to say that the lack of live video was due to limited access to ground stations, which prioritise NASA missions.

Not being able to watch the mission live marks the beginning of a change in how much access the public has to activities in space. Such endeavours have often been presented relatively transparently, at least by NASA and the European Space Agency, in part because they have usually been mostly funded by taxpayers.

The privately funded nature of this mission changes expectations, says space analyst Laura Forczyk. "Yes, this mission is something brand new, and yes we're used to seeing government broadcast because it's taxpayer dollars and transparency is important, but this is a private mission," she says.

While this flight did use some government infrastructure, most notably a launchpad at NASA's Kennedy Space Center in Florida, the rocket, crew capsule and crew training were all provided by SpaceX and paid for by Isaacman.

8

Number of space tourists before 2021

"As this becomes more common, I can't imagine that we as a public should expect to see someone's private vacation," says Forczyk. "Would you or I decide to broadcast our three-day vacation, especially if it's a once-in-a-lifetime thing?"

The answer to that is obviously no, but an average person also wouldn't spend months publicising their holiday beforehand. Much of that publicity centred on the mission's goal to raise awareness and $200 million for St. Jude Children's Research Hospital in Tennessee.

"The question is, to what extent is this a vacation – a tourist trip – and to what extent is this a fundraising mission for St. Jude," says Jonathan McDowell at the Harvard-Smithsonian Center for Astrophysics in Massachusetts. "If it's a fundraising mission, then publicity is part of that mission, but if it's just a fig leaf for 'a billionaire wants to take three friends on a vacation in space' then there's some mixed messaging going on."

There is precedent for space tourists maintaining a certain level of privacy about their trips, even when they have purchased their seat on a spacecraft from government agencies rather than private companies. Before this year, seven tourists had travelled to the International Space Station and one spent a week on Mir, the Russian space station.

"All those people who went to Mir and the International Space Station in the early 90s, they were open about their voyage but they didn't have constant live streaming," says McDowell. "So if you as Jared Isaacman are thinking about yourself as following in their footsteps, he's giving a lot more than they did."

As private space flight becomes more common in the coming years, it seems likely that even the public will come to see it more as a luxury trip for the super-wealthy rather than a collective achievement. And while it is normal to publicly broadcast a collective achievement, holidaymakers tend to prefer their privacy. ▮

Astronomy

Maps of planet-forming zones will help the hunt for alien life

Leah Crane

PLANETARY nurseries have been mapped in the most detail yet, and they are richer than expected in organic molecules – the basic chemical building blocks for life to arise. Studying such maps could help us understand whether we are alone in the universe.

Planets are thought to form in areas of dust and gas called protoplanetary discs, which encircle young stars. We have observed these discs in the past, and even seen signs of planets taking shape in them, but the Molecules with ALMA at Planet-forming Scales (MAPS) project has mapped the chemical composition of these areas in more detail than before, using the Atacama Large Millimeter/submillimeter Array (ALMA).

> "Though bad for complex life forms, cyanides seem to be good for kick-starting the chemistry of life"

The researchers looked at the discs around five nearby stars and found that each has a unique chemical make-up that varies significantly between different areas within each disc (arxiv.org/abs/2109.06268).

"We see this incredible amount of chemical variety, both between and within discs," says Jane Huang at the University of Michigan, part of the MAPS project. "We're seeing these intricate gap and ring structures… and without this high resolution you wouldn't know that was there."

The project examined organic chemicals, a class of carbon-containing substances that are important for the possibility of life as we know it. "There was a lot more of this organic material than we expected – between 10 and 100 times more than our best models had predicted," says MAPS collaborator John Ilee at the University of Leeds, UK.

But not every location in the discs had so much organic material. "We had expected an uneven distribution, but we hadn't expected it to look like this," says MAPS team member Karin Öberg at the Harvard-Smithsonian Center for Astrophysics in Massachusetts. "It might really matter where in the disc and when in the disc's lifetime a planet forms for its inventory of organic chemicals."

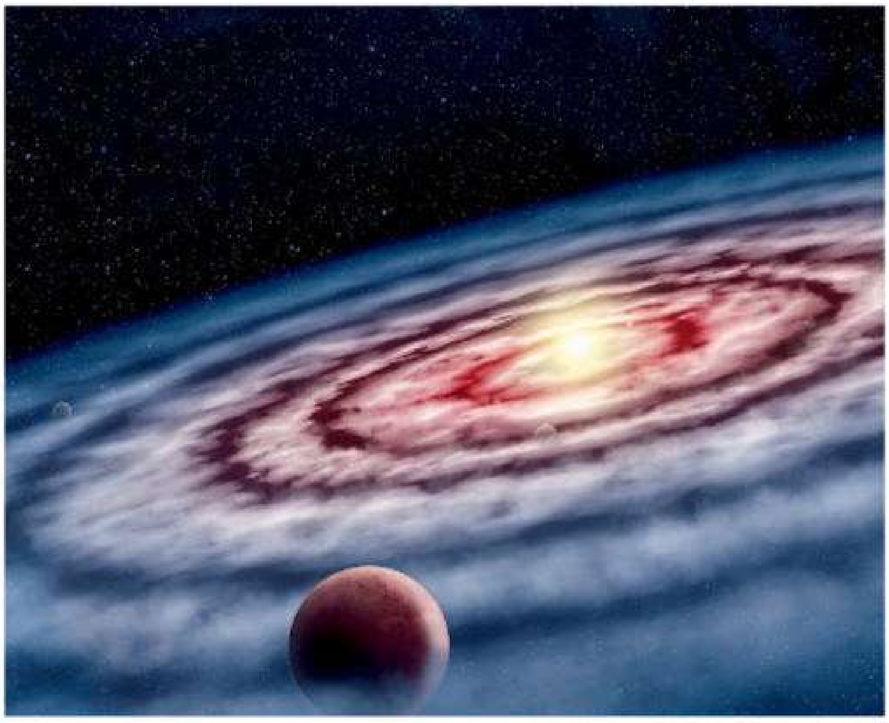
Understanding this is important to figuring out which worlds beyond our solar system might have the potential for alien life. "There are many more steps to go before anything like a little green man is invoked, but we know that these chemicals are important to life on Earth," says Ilee.

One of the most prominent of these organic molecules was cyanide, which the researchers found in all five discs. "Despite being terrible for… complex life forms such as ourselves, cyanides seem to be very good for kick-starting the chemistry of life," says Öberg.

The ubiquity of cyanide-based molecules may be a hint that many worlds scattered around the universe have the right ingredients for life, a promising sign that our solar system may not be particularly special. The chemical compositions of the discs matched up well with the chemicals that we see in comets in our solar system, which are the last remaining relics of our own protoplanetary disc.

But before we can make sweeping statements about all protoplanetary discs, we will have to observe more of them in detail to find out if these five are typical. These are some of the biggest, brightest discs we have seen, which made them easier to observe, but it also means that we can't necessarily use them to generalise about planetary nurseries. ▮

An artist's impression of a protoplanetary disc



M.WEISS/CENTER FOR ASTROPHYSICS/HARVARD & SMITHSONIAN

Bioengineering

Catnip chemical from yeast could be mosquito beater

Michael Le Page

A KEY ingredient in catnip can now be made by genetically engineered yeast, paving the way to a possible new mass-produced insect repellent.

The chemical, nepetalactone, is a very good repellent, but catnip plants (*Nepeta cataria*) don't have enough of it to make production from these commercially viable.

Insect repellents can help prevent serious diseases such as malaria, as well as nuisance bites. DEET is the most widely used mosquito repellent worldwide and is often still the most effective. However, some mosquito populations are evolving resistance to DEET.

Many studies have shown that nepetalactone is an effective insect repellent, with some even finding it more effective than DEET. Yet while catnip in various forms has long been used as a repellent, making a plentiful, cheap version isn't feasible using the plant.

To address this, Vincent Martin and his team at Concordia University in Canada added eight genes to a strain of yeast to create a chemical pathway for making nepetalactone (bioRxiv, doi.org/gwpx).

"We still need to do some work to boost levels," says Martin. "I don't believe it will be a huge hurdle." The main obstacle is that the process also produces a substance toxic to the yeast. However, other groups using yeasts to produce various chemicals have had the same issue and solved it, says Martin.

The researchers are now in talks with companies about getting the investment required to develop the process and commercialise it.

They will also need to look at whether nepetalactone acts as a cat attractant as well as an insect repellent. "If you are walking around with this molecule on you, will there be no mosquitoes, but all the neighbourhood cats chasing you around? To be honest, I don't know," says Martin. ▮

Analysis **Energy**

Green energy didn't cause UK crisis

The UK is facing energy problems as gas prices spike, but the transition to renewables isn't to blame – in fact it is the solution, says **Adam Vaughan**

SOARING wholesale gas prices have left the UK in an energy crisis, with fears for vulnerable households as bills rise and a wave of energy firms folding.

In the 1990s, the UK made a "dash for gas". In recent years, it has leaned on the fuel to phase out an even more polluting fossil fuel, coal. That makes the UK heavily reliant on gas for energy, with 86 per cent of homes using it for heating and more than a third of electricity supplies coming from gas power plants.

The main reason for the current crisis is a shortage of gas supplies, due in part to outages in production in Norway and elsewhere, and demand from Asia. Prices and carbon emissions are up, with ageing coal and mothballed gas power stations firing up again. Wholesale gas prices are up 176 per cent since the start of the year, and power prices in the past month are up 266 per cent on the average this year.

The UK government is reportedly considering offering loans to energy companies that are struggling to cope with the higher wholesale prices, due to both the government's cap on how much firms can charge consumers and a lack of financial hedging against the increase.

It didn't have to be this way. Energy crises like these are a cyclical feature of the volatile nature of fossil fuel prices, subject to global factors beyond the control of any one nation. Countries that have prioritised domestic low-carbon energy are better insulated against such shocks.

People in the UK face rising energy bills this winter as wholesale prices soar

EVGEN PROZHYRKO/GETTY IMAGES

The UK should know this: its last crisis was only in 2018, when the situation wasn't as dire as today, but wholesale gas prices were surging and many energy suppliers were going bust, leaving society to pick up the bill.

Gas prices will be the main problem this winter, but misguided solutions have been thrust to the fore. *The Daily Telegraph* proposes fracking to boost domestic gas production. But firms spent years failing to deliver gas using this method under UK regulations. Others are calling for levies supporting renewables to be shifted off electricity bills, which people would still need to pay through tax.

The UK's nuclear power trade body says nuclear is the answer. Yet a new nuclear plant would take at least a decade to build and could leave energy bill payers shouldering the cost if it goes over budget and schedule.

UK politicians seem to realise the only real long-term fix is to cut the reliance on gas by backing renewables and low-carbon alternatives to gas boilers, such as heat pumps. Energy minister Kwasi Kwarteng said on Twitter that the crisis shows the importance of the UK's plan "to build a strong, home-grown renewable energy sector to further reduce our reliance on fossil fuels". Ed Miliband of the Labour party said on Twitter that the situation was a result of failure to invest enough in "zero carbon energy supplies" and energy efficiency.

The UK has a good track record of supporting renewables and cutting their cost, but not on energy efficiency. Various schemes to boost the energy efficiency of homes have been botched, the most recent being the Green Homes Grant, which was axed after improving only a tenth of the homes it was designed to.

A chance for redemption may come soon. The government is due to publish a UK strategy on heat and buildings, which could help prevent the current energy crisis from being repeated if it sets out bold policies on efficiency and low-carbon heating. ▮

Technology

UK skies to be badly affected by satellite mega constellations

EVERY location on Earth will have hundreds of satellites visible in the night sky, if the launch and operation of mega constellations continues as planned – and the UK's skies will be among the worst hit.

Mega constellations are vast groups of satellites designed to orbit Earth and beam internet to the ground. Notable examples include SpaceX's Starlink and the UK's OneWeb constellations. More than 2000 such satellites have already been launched, with upwards of 65,000 expected in the coming years, including other initiatives from the US and China.

Samantha Lawler at the University of Regina in Canada and her colleagues modelled what the impact of these satellites on the night sky would be from different locations around the world.

"From everywhere on Earth, there [would be] hundreds visible within a couple of hours of dawn and dusk at any time of year," says Lawler.

The most affected areas were at 50 degrees latitude north and south, which includes Canada and the UK. Here, the angle of incoming sunlight means that nearly 300 satellites would remain visible through the night in summertime (arxiv.org/abs/2109.04328).

Although this will have no material impact on the lives of many people, some will be upset by the change. "I don't want that to be the sky my kids grow up knowing," says Lawler.

"In the most affected areas, nearly 300 satellites would remain visible in summertime"

Efforts have been made by SpaceX to reduce the reflectivity of its satellites below naked eye visibility. There are no regulations requiring countries or companies to dim their satellites at all.

Even if satellites are dim enough to be invisible to the naked eye, they will still disrupt astronomical work.

The end result could be a night sky unlike anything previously witnessed by humanity. "One in 15 points in the sky won't be stars," says Lawler. "That's really awful to think about… but that's where we're headed." ▮

Jonathan O'Callaghan

Analysis Climate change

New climate plans fall short

The gap between emissions cuts required for 1.5°C and the pledges made by countries has narrowed by 15 per cent, but it remains significant, finds **Adam Vaughan**

COUNTRIES have failed to come forward with enough bold new plans to cut carbon dioxide emissions in line with the Paris Agreement, according to a new analysis, meaning emissions in nine years' time are expected to be roughly double the level needed to meet the treaty's goal of holding global temperature rises to 1.5°C.

Despite extreme weather in the northern hemisphere, a landmark climate science report and exhortations by UN leaders in recent months, greater ambition on emissions hasn't materialised in the run-up to the critical COP26 climate summit in Glasgow, UK.

The nearly 200 countries that signed up to the Paris Agreement in 2015 agreed to raise the ambition of their emissions reduction plans every five years, starting at the end of 2020. In the past year, the UK, European Union and, in particular, the US put forward significant new plans to slash emissions by 2030. But not enough countries have followed suit to shift the dial globally, the analysis finds.

WENJIE DONG/GETTY IMAGES

An aerial view of a petrochemical plant in China

"With current pledges, we predict that emissions in 2030 would be kind of stable from today – but they would have to be cut in half by 2030 to be in line with the 1.5°C goal of the Paris Agreement," says Niklas Höhne at the non-profit NewClimate Institute, which worked with Climate Action Tracker (CAT) to carry out the analysis, entitled *Global update September 2021*. "So we are roughly emitting twice as much in 2030 as we should."

The gap between the emissions cuts needed for 1.5°C and countries' pledges has closed by up to 15 per cent, or up to 4 billion tonnes of CO_2 equivalent, since last December. "It has narrowed, a bit. But not much," says Höhne. A further 20 to 23 billion tonnes of CO_2eq cuts will be needed to close the gap entirely.

Almost 90 countries plus the European Union's 27 member states, covering about half of global emissions, have put forward new plans. The UK's plan of a 68 per cent cut by 2030 makes it the only high-income country considered by CAT to have a domestic target compatible with the Paris goal of 1.5°C. But adding in factors such as a shortfall of policies to meet the target, the country's contribution is overall ranked "almost sufficient" in the new analysis.

Notably, Höhne and his colleagues found that a group of major emitters had submitted new plans that were the same, or even worse, than their original ones. Australia and Indonesia's were the same. Brazil and Mexico put forward the same numbers but changed the baseline year for measuring cuts, effectively watering them down. "That is for me against the spirit of the Paris Agreement," says Höhne.

Adding the global commitments together, Höhne says they won't "keep 1.5°C alive", as the UK government hopes COP26 will achieve.

A more hopeful picture emerges from the number of countries, accounting for about three-quarters of global emissions, which have said they will hit net zero by mid-century. "But these are long-term promises. They are much easier than the short-term targets for 2030," says Höhne. ▮

Astronomy

Potential exomoon found orbiting a giant rogue planet

ASTRONOMERS may have found an Earth-sized moon orbiting a distant rogue planet. While rogue planets don't orbit a star, in this case the moon may still be warm enough to have liquid water on its surface.

Mary Anne Limbach at Texas A&M University and her colleagues performed a series of calculations to determine whether rogue planets would be good places to look for moons beyond our solar system, called exomoons. While there have been several tentative detections of possible exomoons, none of them has been confirmed yet.

They found that it should be relatively easy to detect exomoons orbiting large rogue planets because there is no glare from a host star. In such a system, the main source of light would be the planet itself, which would continue to glow with the heat generated in its formation. Up to 15 per cent of rogue planets are expected to have moons that pass between them and Earth, blocking out some light and allowing us to detect the moons.

The researchers sorted through archival data from the Spitzer Space Telescope and were surprised to find an exomoon candidate around one of a pair of rogue planets we had already observed, a system called 2MASS J1119-1137 AB (*The Astrophysical Journal Letters*, doi.org/gwd6).

This detection is still highly inconclusive, says Limbach, but if there is an exomoon there, it is probably about 1.7 times the mass of Earth and circling a planet 3.7 to 9.2 times the mass of Jupiter. The potential moon receives roughly the same amount of radiation from its planet as Earth does from the sun. "From the surface of this object, the planet in the sky would be larger than the moon appears from Earth by a factor of 10 or 20, so it would be this giant ball of glowing red ember in the sky," says Limbach.

She and her team plan to make more observations with ground-based telescopes to double-check their find. ▮

"From the surface of this object, the planet would be a giant ball of glowing red ember in the sky"

Leah Crane

Animal behaviour

Your cat is comforted by you, not your smell

Christa Lesté-Lasserre

ANXIOUS cats aren't comforted by objects that smell like their favourite person – and these reminders could even make them howl more in their owner's absence.

Unlike human babies, cats don't accept scent alone as a worthy stand-in for the people they have bonded with, says Kristyn Vitale at Unity College in Maine.

Cat owners are sometimes told to leave an item of their clothing with their pets when they have to be separated, such as in a pet hotel. To see whether this is actually helpful, Vitale and her colleagues set up a test for 42 people and their cats.

Each owner sat in the middle of a 2-metre-wide circle, while their cat roamed freely in an unfamiliar room. Then the owner left the cat alone. Next, the cats experienced one of two sequences. For some, their owner came back, then left them alone again, and then finally a scented object was left in the room; for others, the object was presented first and then the owners returned after the cat had been alone.

Most of the cats showed signs of bonding with their owners, rubbing against them when they returned to the room and meowing nervously when they were absent, says Vitale. Regardless of which sequence they experienced, the cats generally paid no attention to the scented object and didn't act any calmer than when they were alone without the object.

In fact, 38 per cent of them were more vocal when the scented object was in the room than when they were alone without it (*Applied Animal Behaviour Science*, doi.org/gv9b). Many of the cats appeared less reassured by their owners' presence if they had been given the scented object as a substitute first.

It may be that cats need more general social interaction with their owner. "Things like warmth, touch and vocalisation could all be important as well," says Vitale. ▮

Quantum technology

City-wide quantum network in China is largest yet

Matthew Sparkes

A CITY-WIDE quantum communications network in Hefei, China, that has been running for almost three years is the largest demonstration to date of how a future quantum internet might work.

The network, created by Teng-Yun Chen at the University of Science and Technology of China (USTC) and his colleagues, uses commercial fibre optics hardware to connect 40 computers at government buildings, banks and universities that are clustered into three subnetworks, each separated by around 15 kilometres.

49.5

Speed of the quantum network, in kilobits per second

In a traditional computer network, data is sent in small packets that can be intercepted by anyone. With enough time and computing power, even encrypted messages can be cracked open.

On the other hand, quantum key distribution offers the promise of completely secure encrypted communications by sending photons in particular quantum states. Any attempt to observe or copy a quantum state will alter it, thanks to the strange properties of quantum physics, making it impossible to eavesdrop on a quantum connection without raising the alarm.

The most robust way to build a quantum network is to have a link between each and every user, but this becomes prohibitively expensive for all but the smallest networks – imagine a version of the internet in which you need a direct connection to every other computer. To get around this, the USTC team used smaller subnetworks and switches that can create routes between different users as needed, like a telephone operator patching wires together.

The network also includes three devices known as trusted relays, which are used to simplify the network architecture. These relays do have a major downside, because they could, in theory, be used to intercept data being transmitted between two users without their knowledge.

Another disadvantage is that the network only transmits at 49.5 kilobits per second – slower than the telephone modems used in the 1990s – and establishing a secure quantum link takes up to 5 minutes because of the precise calibration required to detect individual photons.

In their paper, the researchers say that their network has been operating for 31 months, and it can be connected to other similar set-ups via long-distance quantum links and satellite relays, paving the way for a global quantum network (*npj Quantum Information*, doi.org/gmsb7s). The team wasn't available for interview about the work when contacted by *New Scientist*.

The quantum network runs on standard fibre optics

SHUTTERSTOCK/ASHARKYU

Quantum telegraph

Siddarth Joshi at the University of Bristol, UK, says the experiment can be considered a large-scale demonstration of a first-generation quantum network. In a second-generation network – also referred to as the "quantum internet" – users would be able to share photons directly and avoid the need for trusted relays.

"Think of going from the telegraph to telephone, and then the internet," says Joshi. "In terms of quantum communication, we have done the telegraph, point to point. Now we have the kind of telephone system where you have an operator sitting in front of a switch box, plugging connections in. We want to go on to something far more seamless in the future."

Richard Penty at the University of Cambridge says that the approach borrows architecture from classical communications and that this is the largest metropolitan quantum communications network yet demonstrated – even if it isn't yet fast enough to be used for everyday use.

"It's showing how people are starting to deploy things that are getting towards real-world applications," he says. "I wouldn't call this a real-world application yet, but it's heading in that direction." ▮

Environment

Proposed bin tax could help the UK hit net-zero goals

Adam Vaughan

HOUSEHOLDS in England should be made to pay for the amount of rubbish they throw away and be banned from putting plastic in their bins to boost recycling, UK government advisers have urged ministers.

Domestic recycling rates in England have stalled at about 45 per cent of waste since 2012, leaving lots of rubbish still being sent to landfill or burned in incinerators.

A "pay-as-you-throw" rubbish scheme was last seriously examined in England 14 years ago. It would use microchips on bins to weigh rubbish, and rebates on council tax as an incentive to recycle more. But a national roll-out was rejected after criticism.

Now the concept has been put back on the agenda after the Advisory Committee on Packaging (ACP), an expert group appointed by the UK government, said it should be explored to minimise waste and spur recycling. Another option would be reducing the frequency of "black bag" waste collections, the group said in a response to a consultation on consistency of recycling across England, seen by *New Scientist*.

"The UK will have to deal with its own recycling as many countries have banned plastic imports"

"Pay-as-you-throw could increase householder involvement in waste issues and introduce a market mechanism – money – to influence their and business's waste generation," says Deep Sagar at the ACP. The measure would probably cut the total waste each home generates, similar to reductions seen after a 10 pence charge on single-use plastic bags was implemented in England. The potential downsides, he adds, are the cost of administering such a scheme and the risk of people dumping rubbish illegally instead of reducing waste or recycling more.

BAILEY-COOPER PHOTOGRAPHY/ALAMY

A row of rubbish bins on a street in North Yorkshire, UK

The UK's Department for Environment, Food & Rural Affairs (Defra) told *New Scientist* that it has no plans to introduce pay-as-you-throw, but would be using powers in the environment bill currently going through the UK Parliament to make collections more uniform regionally. "This will make recycling easier and ensure there is a comprehensive, consistent service across England, reducing recycling confusion and ensuring more recycled material is used in the products we buy," said a Defra spokesperson in a statement.

The ACP lamented a "regrettable lack" of engagement with households on how to curb waste and improve recycling rates. Pay-as-you-throw should be accompanied by a ban on putting plastics, textiles and electronics in household rubbish in England, the committee said in another waste consultation.

The ACP also says a deposit return scheme planned for England, Wales and Northern Ireland in 2024 should be paused, to learn more first from Scotland's experience of its own scheme starting in 2022. The committee argues that such a scheme could be too costly and the measure might reduce how much people recycle at home.

Recycling rates will have to be boosted to hit the UK's net-zero climate target, and tackle the twin challenges of vanishing landfill space and opposition to more incinerators. There is also a growing realisation that the UK will soon have to deal with more of its own recycling, as a wave of countries to which materials for recycling are usually exported have plans to ban plastic waste imports, as Turkey did in July. ■

Space

NASA Perseverance rover hit by 100 dust devils on Mars

Jonathan O'Callaghan

NASA's latest Mars rover, Perseverance, encountered 100 dust devils in its first 90 days on Mars after landing in February.

Small whirlwinds on Mars, known as vortices, aren't uncommon. They can be tens of metres wide and several kilometres high, with wind speeds upwards of 100 kilometres per hour. Many have been detected by other missions on Mars, such as the Curiosity rover and InSight lander.

If these vortices lift up Martian dust, they can form so-called dust devils – dusty columns towering into the air. Dust devils also occur in Earth's deserts, although the exact formation mechanism on both Earth and Mars is unclear. Dust plays a key role in the Martian climate, trapping more heat in dustier locations.

Brian Jackson at Boise State University in Idaho used data from Perseverance's Mars Environmental Dynamics Analyzer instrument suite to study its exposure to local dust devils.

In the rover's first 89 Martian days (or sols), equivalent to 91 Earth days, 309 vortices passed over the rover, a third of which were dust devils – about five to 10 times higher than the number experienced by Curiosity at Gale crater (arxiv.org/abs/2109.04601).

"What it's telling us is dust devils are very active at Jezero crater [Perseverance's location]," says Jackson. That may be because it has a larger amount of both bright and dark terrain, creating more convective currents from their temperature differences.

Dust devils pose few problems to the nuclear-powered rover, but the findings show we are able to predict the regions on Mars that experience more of these phenomena.

That could have implications for where on Mars to send future human missions. "The dust on Mars is actually toxic," says Jackson. ■

Environment

Big increase in fish demand by 2050

Brazil, India and Nigeria are among the countries predicted to double their consumption of fish

Adam Vaughan

THE world's hunger for fish is expected to almost double by 2050 due to growing affluence and populations, according to an assessment that anticipates the demand being fed by a big rise in farmed seafood.

Global fish consumption has already doubled since 1998, but a team led by Rosamond Naylor at Stanford University in California projects a further 80 per cent increase by mid-century. Whether that proves good or bad for the environment and nutrition will rest on what types of fish people choose to eat, say the researchers.

"We talk about fish as a monolithic thing, but actually it's highly diverse," says Naylor's colleague, Beatrice Crona at the Stockholm Resilience Centre in Sweden. "Preferences will play a big role to whether we can convince some people to eat small pelagic fish [such as sardines] or mussels, which are also low [environmental] impact but highly nutritious."

Supplying the increase in demand with a big expansion of farmed salmon, as pioneered by Norway and Chile, wouldn't be feasible because of the environmental side effects and inefficiencies of using a species so high up the food chain, says Crona. Salmon farming has been linked with water pollution and spreading parasites to wild fish.

Brazil, Ghana, India, Mexico and Nigeria are all expected to more than double the weight of fish they consume by 2050. China, meanwhile, will remain the biggest consumer, expanding its appetite from just over 50 million tonnes of fish in 2015 to just under 100 million by 2050. The growth is expected to decrease meat and dairy demand per person in countries including China and the US, and raise the intake of iron, calcium and vitamin B12.

The researchers arrived at their figures using modelling based on UN Food and Agriculture Organization (FAO) data on what fish species people ate in 10 countries that account for 55 per cent of global fish consumption, and on World Bank and International Monetary Fund estimates of future economic and population growth. The researchers considered the 10 countries indicative of global trends (*Nature Communications*, doi.org/gwdj).

However, the analysis does rely on some assumptions that are open to challenge. One is that supply perfectly matches demand so prices don't rise relative to incomes. That rests on the growth in supply "mainly" coming from farmed fish – Naylor says it is likely to grow by 90 per cent – which the researchers say is "plausible" given the industry's past growth.

Small pelagic fish like sardines are highly nutritious

SHUTTERSTOCK/ERMESS

But it isn't a given that farmed fish can feed growing demand. "As aquaculture accounts for only around 5 per cent of world production of marine fishes, it is challenging for aquaculture to bridge the gap between future demand and supply of marine fishes, especially with the generally negative public images of aquaculture in many countries," says Junning Cai at the FAO, who wasn't involved in the study.

Shifts towards plant-based diets in some countries due to environmental concerns also mean history may not be a good guide to the future, says Crona. "We are facing an environmental crisis we have not seen before. In response to that, younger generations are making different choices," she says.

A third factor highlighted by the team is the wild card of climate change, which could disrupt growth in farmed fish through extreme weather. ▮

Social media

Fake German TikTok users could spread false election info

TIKTOK accounts that falsely claim to be run by German politicians and political institutions aren't being flagged by the video-sharing platform.

In July, TikTok rolled out a banner in Germany pointing users to a dedicated information hub on the 28 September federal election. The intention was for this to be automatically displayed alongside videos labelled with relevant hashtags such as SPD, one of the ruling German parties, in an effort to combat potentially harmful videos.

But Becca Ricks at tech firm Mozilla has found that this warning isn't consistently applied. For example, some videos unrelated to politics, but using the SPD hashtag to refer to a condition called sensory processing disorder, display the banner, while other videos that are explicitly political, posted by official accounts run by parties like Alternative für Deutschland, haven't had a banner appended.

"The platform publicly has made statements that they care about these issues and want to get it right," says Ricks, who conducted the analysis with independent researcher Marcus Bösch. "They haven't backed up some of these policy decisions with effective resources."

The researchers also discovered a number of fake accounts followed by tens of thousands of people. These claimed to be run by politicians, but weren't official, in breach of TikTok's rules around impersonation.

76%

Proportion of German TikTok users who are old enough to vote

Internal TikTok data from mid-2020, seen by *New Scientist*, indicates TikTok has 10.7 million active users a month in Germany, 76 per cent of whom are over the voting age of 18, so 13.5 per cent of voters could be reached by these fake accounts.

"Our community values authentic content and we do too," says a TikTok spokesperson. "For the 2021 German federal elections, we are directing our community in Germany to trusted information on our in-app election hub." ▮

Chris Stokel-Walker

Archaeology

ASHMOLEAN MUSEUM/HERITAGE IMAGES/GETTY IMAGES

AI solves riddle of missing text on ancient clay tablets

A DEEP-LEARNING artificial intelligence (AI) model can predict missing words, fragments and sentences from cuneiform tablets that are up to 4500 years old.

Clay tablets with text written in the Akkadian language (pictured) help us understand the cultures in and around Mesopotamia – centred on present day Iraq – between 2500 BC and AD 100. But the age of the tablets means key sections of text are sometimes missing.

Computer scientist Gabriel Stanovsky at the Hebrew University of Jerusalem and his colleagues used AI to tackle this problem. They turned to a deep-learning AI model already trained on 104 different languages, including some Semitic languages such as Hebrew, which shares similarities with Akkadian. They then fed the AI transcriptions of 10,000 cuneiform tablets. The model could suggest contextually accurate words and phrases to fill in the gaps in new cuneiform tablets it was shown, similar to the way a phone keyboard autosuggests the next word in a sentence.

The suggestions were tested by hiding known parts of the tablets and seeing if the model could complete them, which it could with 89 per cent accuracy – and occasionally even expanded possible interpretations of texts (arxiv.org/abs/2109.04513). "Sometimes the model threw [the experts] into a new line of thinking they didn't have," says Stanovsky.

Shai Gordin at Ariel University, Israel, who has also studied the use of AI to fill gaps in cuneiform tablets, says the model has "great potential". **Chris Stokel-Walker**

Health

HPV infection raises premature birth risk

PREGNANT women infected with the human papillomavirus (HPV), which can cause cervical cancer, are nearly four times more likely to give birth prematurely.

The finding suggests that as more teenagers are vaccinated against HPV, there will be fewer premature births, says Helen Trottier at the University of Montreal in Canada. Premature babies are born smaller and are more prone to infections and numerous other health problems.

HPV is a sexually transmitted virus that is shrugged off naturally by most people, but it can linger and cause cancers, including of the cervix, as well as genital warts.

Most high-income countries started offering HPV vaccination to teenagers about a decade ago. Rates of genital warts have started falling, although any effect on cervical cancer rates is taking longer to show up, as it takes many years to develop.

Trottier wondered what the effects of the virus would be on pregnant women. Her team tested nearly 900 women for HPV in their vaginal fluid in the first and last three months of pregnancy. About 42 per cent tested positive at the start, and two-thirds of these still had the virus by the end.

Those who had HPV throughout pregnancy were 3.7 times more likely to either spontaneously go into early labour, or need to be induced to give birth early due to complications, compared with those who had tested negative at the start of pregnancy (*JAMA Network Open*, doi.org/gwb4).

If the virus is directly causing premature labour, the mechanism is unclear. HPV doesn't trigger inflammation, a known cause of premature birth, but it could harm cells of the cervix, making them more vulnerable to infection by bacteria that cause inflammation, says Trottier. **Clare Wilson**

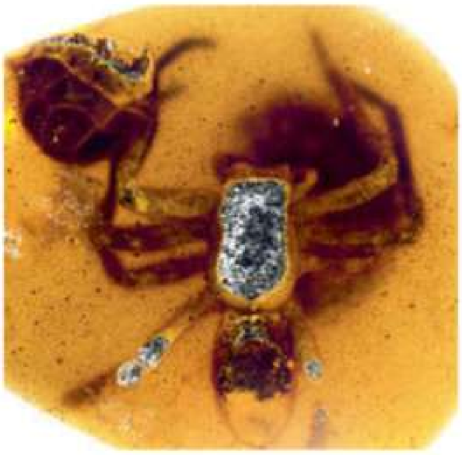
Palaeontology

Ancient spiders were dedicated mothers

MODERN spiders are known to take care of their eggs and young – and now we have evidence that the behaviour goes back a long way.

Researchers at Capital Normal University in Beijing and Paul Selden at the Natural History Museum in London analysed four specimens of spiders trapped in Burmese amber, dated to 98.8 million years ago.

All feature lagonomegopids, an extinct spider family. In one specimen, a 7.5-millimetre-long female lagonomegopid clutches an egg sac filled with embryonic spiderlings wrapped in silk.



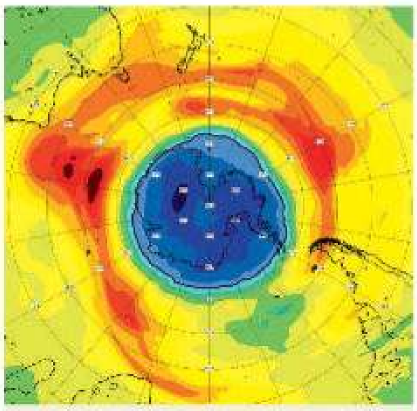
DR. DONG REN

The three other specimens contain 24, 26, and 34 recently hatched spiderlings, respectively. In two of these specimens, the researchers also identified adult spider legs, presumably belonging to the mother, and one of these two specimens also contained silk strands wrapped around pieces of wood and other debris, which are probably the remains of a spider nest (*Proceedings of the Royal Society B*, doi.org/gwb3).

The findings hint that spiderlings in this species lived as a family in a nest guarded by the mother, says Selden. The preservation of the mother's legs in two of the amber specimens suggest she would choose to stay with her offspring even as tree resin slowly immersed the nest.
Christa Lesté-Lasserre

New Scientist Daily
Get the latest scientific discoveries in your inbox
newscientist.com/sign-up

Really brief



COPERNICUS ATMOSPHERE MONITORING SERVICE/ECMWF

Ozone hole is bigger than Antarctica

The hole in the ozone layer that opens up annually over the South Pole is bigger than Antarctica this year, making it larger at this point in the calendar than 75 per cent of the holes since 1979. It is unclear why the hole is so big this year, but it doesn't necessarily mean ozone recovery is off track.

Ancient elephant nursery uncovered

Prehistoric footprints in Spain show a species of straight-tusked elephant (*Palaeoloxodon antiquus*) raised its young among coastal dunes there 100,000 years ago. Neanderthal footprints and tools at the site suggest the young elephants were hunted (*Scientific Reports*, doi.org/gwbv).

Seed-like sensors could monitor air

Flying wireless sensors inspired by gliding seeds could be used to detect heavy metals in air and catch particulate pollution. The devices could also transmit information using external power sources like those used to power contactless credit cards (*Nature*, DOI: 10.1038/s41586-021-03847-y).

Coronavirus

5-minute test for covid-19 antibodies

A CHEAP, quick test can accurately determine whether you have had covid-19 in the past or if you have vaccine protection by detecting antibodies in blood or saliva.

When a person is infected with the coronavirus or is vaccinated against it, their immune system produces antibodies to fight the virus. These continue to be made for at least six months, so they can be used to detect a past infection or vaccine response. Tests for these antibodies already exist, but they tend to be expensive, complicated or not very accurate.

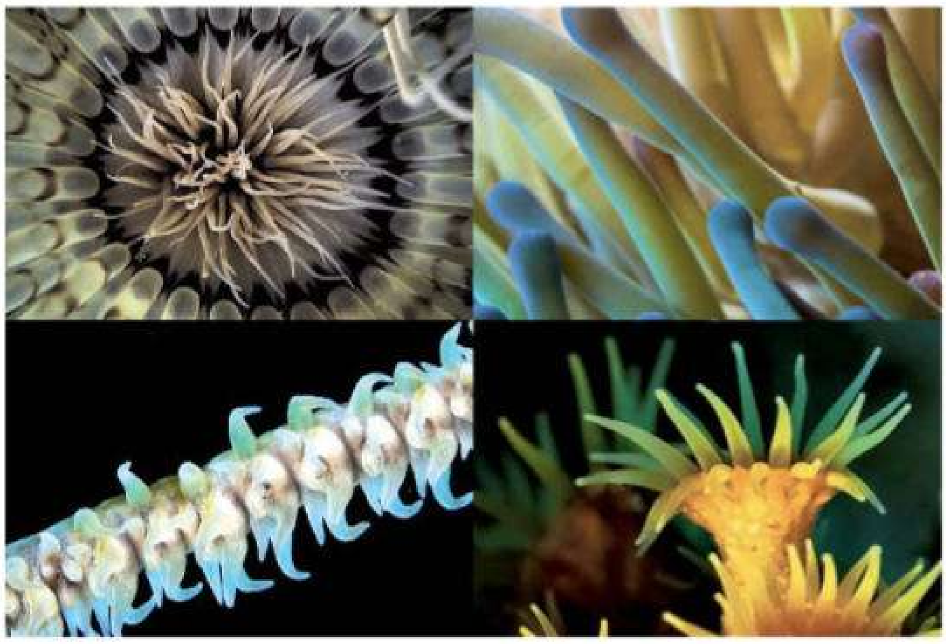
Feng Yan at the Hong Kong Polytechnic University and his colleagues made a cheaper, more convenient test using organic electrochemical transistors. These convert biological signals to electrical ones, and are becoming popular for detecting biological molecules like proteins.

A drop of blood or saliva is placed on one of these transistors. As coronavirus antibodies bind to it, the transistor produces electrical signals that are read by a lightweight portable meter connected via Bluetooth to a mobile phone. The whole process takes less than 5 minutes.

The test proved highly accurate when tried on samples of blood and saliva spiked with different coronavirus antibody levels, including very low levels (*Science Advances*, doi.org/gwb8).

Yan and his colleagues are now planning a clinical trial to confirm this works in real-world settings. If successful, the team will apply for approval to sell the test, which should cost less than $1 per test strip, says Yan. **Alice Klein**

Marine biology



KEELING PJ ET AL., 2021, PLOS PATHOGENS, CC-BY 4.0

Strange new form of parasite lives on corals

IT HAS long been known that coral polyps harbour algal symbionts that make most of their food. Now it has been shown that corals (pictured) can also harbour microbes that appear to be parasites, but don't seem to harm their hosts.

Around a decade or so ago, Patrick Keeling at the University of British Columbia in Canada and his colleagues realised that some genetic sequences that turned up in studies of coral actually belonged to a previously unknown group of single-celled organisms with complex cells, unlike bacteria. The team has gone on to find and isolate these, dubbed corallicolids.

They don't obviously harm corals, but are almost certainly parasites, says Keeling. "It's hard to see how they could be beneficial."

What is most mystifying is that the corallicolids appear to make a little chlorophyll that can capture light energy, but have lost the apparatus for using that energy to make food (*PLoS Pathogens*, doi.org/gwbw).

Metagenomic studies suggest that the corallicolids are just one of 10 previously unknown groups of organisms on coral reefs, and Keeling thinks there are many more groups waiting to be discovered. **Michael Le Page**

Materials

Natural way to make water flow uphill

A STRANGE leaf has inspired a new type of material that can affect the flow of liquids. The scaly texture of the leaf forces fluids with different properties to flow in opposite directions – even if one is uphill.

Araucaria evergreen trees – including some known as monkey puzzles – have spiky, cylindrical leaves made up of smaller, scale-like segments called ratchets. Zuankai Wang at City University of Hong Kong and his team looked more closely at these leaves after noticing them in a park.

They found that the shapes of these layers of ratchets give the leaves a special property. When placed on an *Araucaria* leaf, liquids with a low surface tension – the degree to which the particles in the surface layer of the liquid stick together – flow in the direction the ratchets point. Liquids with a high surface tension flow in the opposite direction, even upwards.

The researchers made a strip of plastic with the texture of the leaf to investigate further. When a water and oil mixture was placed on the strip, the two separated, with the lower surface tension oil flowing along the ratchets and the higher surface tension water flowing against them (*Science*, doi.org/gwch). **Leah Crane**

PAY JUST £2.71* A WEEK

New Scientist
Subscriptions

EXPIRY DATE: NEVER
NEW SCIENTIST for the alleviation of symptoms of an undernourished brain
TO BE TAKEN WEEKLY, DAILY OR AS REQUIRED
New Scientist
YOUR RECOMMENDED DAILY EVERYTHING

INTRODUCTORY
OFFER
SAVE
UP TO 80%

Your recommended dose of *New Scientist*

Whether you want the best, most trusted information, or are just seeking a sense of wonder in the world, there's only one miracle drug you need: a regular dose of *New Scientist*. Available when you want it, how you want to take it – in print, online, on audio and in our app.

Subscribe today to feel the full benefits

Visit newscientist.com/introoffer
Call: +44 (0) 330 333 9470, quoting 16484

Subscriber benefits**

51 print editions through your letter box
365 days of unlimited access to newscientist.com
400+ issues in the app including audio versions of many articles
200+ video science talks to immerse yourself in
200+ interactive puzzles and crosswords (added weekly)
4 exclusive subscriber-only online events a year

New Scientist.
The world, better understood

Offer ends 26 November 2021. In the unlikely event that you wish to cancel your subscription, we offer a 14-day cooling off period after initial payment is made. Savings based on a Print + App + Web subscription during a 12 week period. This is an auto-renewing subscription - cancel anytime within your initial subscription period and you won't be charged anything further.
*Weekly price of £2.71 based on Print + App + Web subscription package charged on the 12-week introductory offer.
** Subscriber benefits based on an annual subscription.

Views

The columnist
Graham Lawton on the mental toll of climate change p24

Aperture
Astronomy Photographer of the Year winners p26

Letters
Uncertainties on the journey to a net-zero life p28

Culture
Denis Villeneuve's action-packed remake of *Dune* p31

Culture columnist
Psychonauts 2 is a witty, stylish game, finds **Jacob Aron** p32

Comment

A hard line to walk

Plans to change how medicines are assessed in England and Wales mustn't weaken safety precautions, says **Clare Wilson**

Clare Wilson is a medical reporter at *New Scientist*
@ClareWilsonMed

MICHELLE D'URBANO

LAST month, plans were announced to change the way new medicines are assessed by the National Institute for Health and Care Excellence (NICE). This body decides which medicines can be used in the National Health Services in England and Wales. While some proposals are clearly welcome, like getting firms to put submissions to NICE in plain English, others require caution, like accepting less rigorously conducted trials as supporting evidence.

NICE says the changes are designed to speed up the introduction of new medicines and support innovation by pharmaceutical companies. It also wants to encourage drug companies to launch their products in the UK first, now the country has left the European Union. Faster access to medicines sounds like an unalloyed good, but the experience of the US Food and Drug Administration (FDA) when trying to achieve the same thing is a cautionary tale.

The FDA has a different job to NICE: to assess whether new medicines are safe, effective and are manufactured properly. The UK has an equivalent body that does that: the Medicines and Healthcare Products Regulatory Agency. NICE assesses medicines on a fourth criterion: whether the benefits brought by a treatment are worth the price. Nevertheless, both the FDA and NICE act as brakes that stop pharmaceutical firms from being able to market whatever medicines they like.

The FDA has come in for criticism for letting an increasing number of products be reviewed under fast-track schemes that require less stringent proof. Companies that get fast-track approval are supposed to carry out randomised trials after a product's launch to show it really is effective, and to stop selling their medicine if the trial finds it doesn't work.

But the system isn't always working as intended. In many cases, the companies' post-approval trials are delayed for years. Even if a trial is negative, a drug might not be withdrawn; a study of fast-tracked cancer medicines in the US found that one-third were still in use years after being found not to work.

The FDA's most recent controversy was over its approval, in June, of Aduhelm to treat Alzheimer's disease, after its scientific advisory panel advised against the move, triggering resignations and an inquiry.

The fact that the FDA has these problems doesn't mean that NICE will go the same way. But NICE's consultation document, which invites the public to give feedback on its proposals, gives the impression that there is little need for caution. Its website says the moves are to allow "earlier patient access to valuable innovative treatments". Few people are likely to respond saying they want slower access to medicines, suggesting the consultation is something of a PR exercise.

Another of the proposed changes is to accept less stringent forms of supporting evidence, namely non-randomised trials and "real-world evidence". In practice, the latter means hearing reports from people who have the relevant medical condition about their experience with the drug or how much they want to receive it.

Such testimonies are often organised by patient support charities that take funding from the manufacturers and so may be biased. Seven out of 10 such charities contributing to NICE appraisals had recently received money from the manufacturer of the medicine under review, according to a 2019 study.

NICE already does a difficult job, balancing the needs of patients against National Health Service budgets, without upsetting big pharma too much. Now it has political masters who want it to fulfil another role: showing that Brexit has been a success. Let us hope that this important medical body manages to successfully walk the tightrope. ▮

No planet B

Ecological grief Climate change is taking a huge toll on our mental health, particularly for young people and those on the front line. But it could help us find a way forward, writes **Graham Lawton**

Graham Lawton is a staff writer at *New Scientist* and author of *This Book Could Save Your Life*. You can follow him @grahamlawton

Graham's week

What I'm reading
How to Be a Liberal: The story of freedom and the fight for its survival *by Ian Dunt.*

What I'm watching
Vigil, *the BBC's submarine-based murder mystery/political thriller.*

What I'm working on
I'm on a deep dive into the mind-bogglingly huge mineral requirements for the clean energy revolution.

This column appears monthly. Up next week: Annalee Newitz

A WEEK into our family holiday in Greece, the thing we feared the most happened: a fire broke out on the hillside next to our house. Through the smoke, we could see trees and brush going up in flames. When an outhouse on the neighbouring property caught fire, we grabbed passports, wallets and phones, piled into the car and fled.

There was nothing for it but to go to a beach and wait. A few hours later, we returned. The fire was out, the house and village intact. We were relieved and grateful, but shaken, and edgy for the rest of the holiday. Having briefly feared the loss of a rented holiday home and a longed-for family break, I can only imagine what it feels like to lose an actual home to a natural disaster, or to live in fear of it. Yet this is the experience of increasing numbers of people around the world as fires, floods, storms and melting ice invade our safest spaces.

Such climate-fuelled natural disasters are obviously a danger to life, limb and property. But what is often overlooked is that they also take a psychological toll. According to the UK's Royal College of Psychiatrists, the climate emergency is also a mental health emergency, because our psychological well-being is entwined with the natural world.

For now, the people on the front line of this crisis are Indigenous communities who have a profound connection to the land, and who are being psychologically obliterated by the destruction they see being wrought upon it.

One vivid example comes from Tikigâksuagusik, a coastal Inuit community in Labrador, Canada. There is no road in or out of the town, and its 300 or so inhabitants still live largely as their ancestors did. According to Ashlee Cunsolo, a researcher at the Labrador Institute who has worked with the community for 12 years, the people of Tikigâksuagusik are deeply connected to their environment. They use the land and sea to hunt, trap, fish and forage, and derive a sense of belonging from being in the wild. Above all, she says, they identify as "people of the sea ice".

Yet that sea ice is disappearing. Labrador is the fastest-warming region of Canada. It has long exceeded a 1.5°C average rise in temperature and is heading for much more. The sea ice season has shrunk from eight months to just five, and the ice that forms is thin and weak. The weather has also become snowier and foggier, limiting opportunities to hunt and forage on land. Last winter was the warmest on record, with the average temperature 4 to 6°C above normal and no days at all with an average temperature of below -20°C, compared with at least 20 such days in a normal year.

> "Over 45 per cent of 16 to 25 year olds say their worries about climate change are negatively affecting their daily lives"

The result, says Cunsolo, is disconnect from the environment, a profound sense of loss and an epidemic of emotional problems. People in Tikigâksuagusik report feeling sadness, stress, anger, frustration and hopelessness. Rates of depression, anxiety and substance abuse are rising, as are suicide ideation and attempts.

There is an emerging name for such responses: ecological grief. It can be broken down into three components. The first is a direct sense of loss when treasured species and ecosystems disappear. The second is grief at the loss of traditional knowledge and personal identity. The third is anxiety about future losses and those endured by other people.

For now, the first kind of grief is largely confined to traditional communities around the world that are experiencing the losses directly, says Cunsolo. But the second is being seen in groups such as farmers, fishers and foresters, and the third is increasingly being detected among people everywhere, especially the young.

Last week, for instance, a global survey of 10,000 people aged 16 to 25 found that nearly 60 per cent of them are very or extremely worried about climate change. More than half felt sad, anxious, angry, guilty, powerless or helpless, and over 45 per cent said their worries about climate change were negatively affecting their daily lives.

There is evidence that even in Western societies, extreme climate-related events are starting to gnaw at psychological health. In the UK, for example, people whose homes have been flooded in an extreme weather event have higher rates of anxiety, depression and post-traumatic stress disorder than the general population. In terms of healthy life years lost, "the mental health effects of flooding are much more important than the physical effects", says Lisa Page at the UK Royal College of Psychiatry.

Climate anxiety and ecological grief will get worse before they can get better. But, paradoxically, despair breeds hope. Cunsolo points out that grief is a healthy response to loss and could be harnessed in our response to the crisis. "I actually think that there's a really powerful moment that's happening here as more and more people are coming together in grief," she says. The world is on fire, but we may yet conjure a phoenix to rise from the flames. ▮

New Scientist Academy

SAVE £100*

KNOW YOUR MIND

Is this the real life? Or is this just fantasy?
Discover how consciousness creates the world around you.

What's the nature of existence? And is reality what we think it is? Find out in our immersive Secrets of Consciousness online course at newscientist.com/secrets-of-consciousness

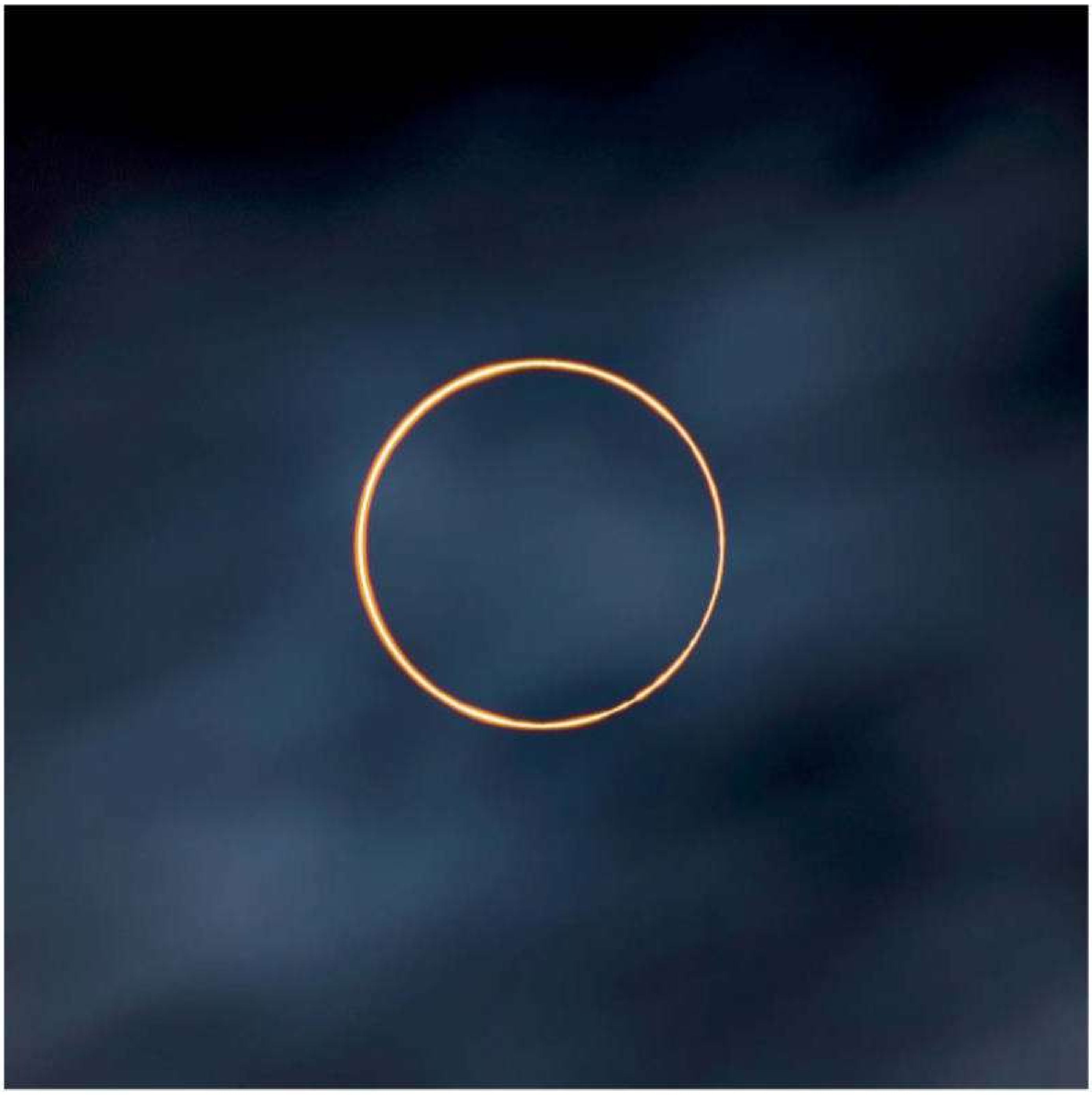
Register today and save £100*.
Quote code: NS250921

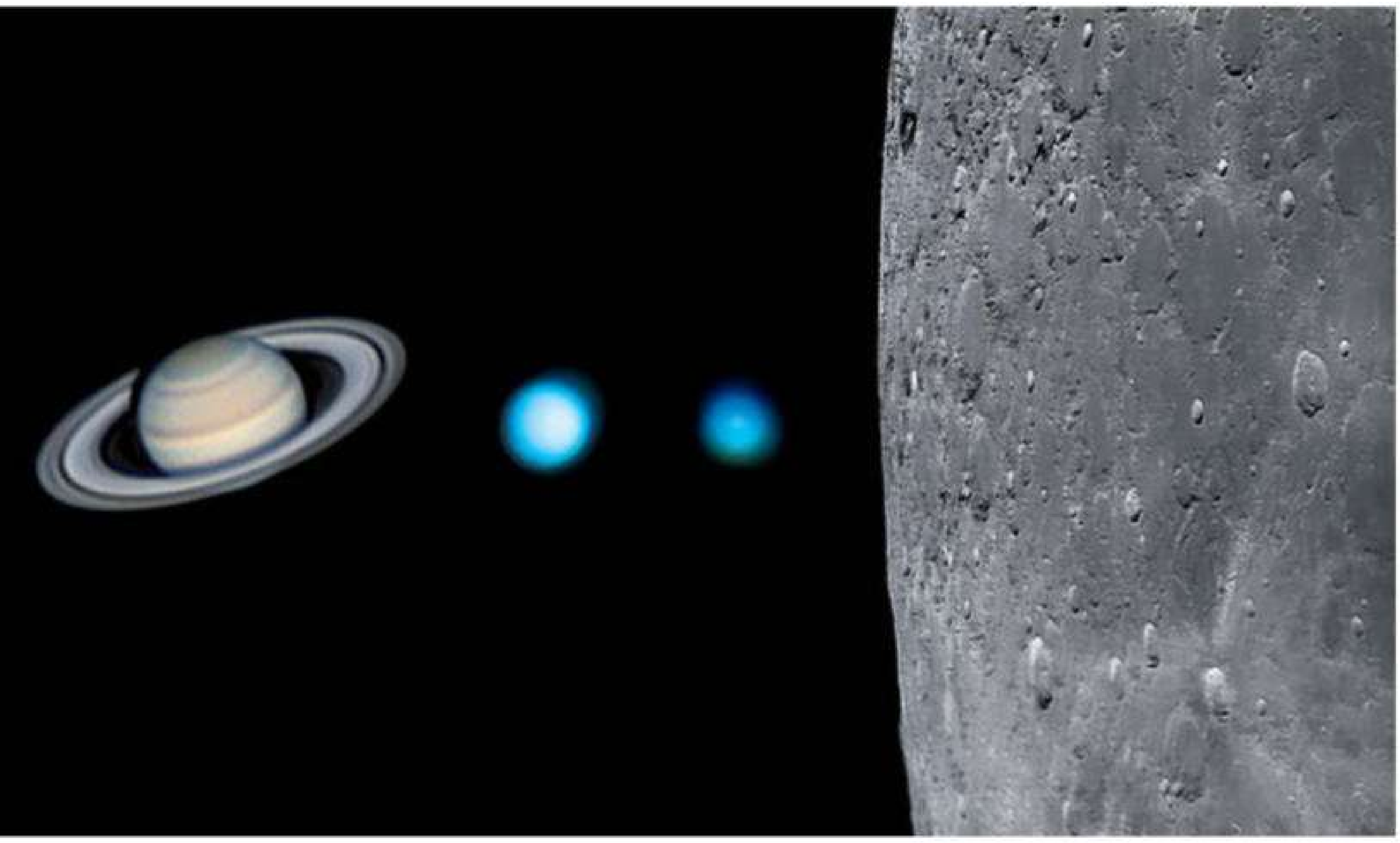
* Offer ends 30 September

New Scientist Academy

Reassess your reality on our Secrets of Consciousness course

Consciousness





Heavenly art

Photographers **Nicolas Lefaudeux, Shuchang Dong and Zhipu Wang**

THESE three enchanting images showcasing the simple beauty of space have taken top prizes in this year's Astronomy Photographer of the Year competition, organised by the Royal Observatory in Greenwich, London.

The image shown top left was taken by Nicolas Lefaudeux, who won in the category Our Moon. Called *Beyond the Limb*, it shows the subtle crescent of Venus rising above the horizon of the moon.

Shuchang Dong was the competition's overall winner for his picture, *The Golden Ring* (top right), taken during an annular solar eclipse in June 2020. Dong captured this rare and fleeting shot from Ali, Tibet, as the sun, moon and Earth aligned. Annular eclipses occur when the moon moves in front of the sun, but appears smaller than our star, resulting in a bright ring of light.

At the bottom of the page is *Family Photo of the Solar System* by 15-year-old Zhipu Wang, who won the Young competition category. Wang created this composite image of the planets in the solar system (except Earth), framed by the sun and moon.

The winning images will be exhibited at the National Maritime Museum in London from 18 September. ▮

Gege Li

Editor's pick

Uncertainties on the journey to a net-zero life

4 September, p 34

From Liz Bell,
Great Shefford, Berkshire, UK

I was intrigued by a suggestion in your look at net-zero living from Hayden Wood at UK green energy firm Bulb. He said "it makes no sense to have gigawatts of battery capacity in people's cars [that is] not being used to help balance the grid".

Actually, it does. We are pleased to have our first family electric car. But when we plug it in overnight, we expect to find it fully charged for our use in the morning, not to find it only partially charged after being raided to balance the grid. This would be particularly important if we were planning a long journey.

Batteries will be necessary to balance the grid, but surely it would be better to install one in each home for this purpose. The ebb and flow in them while balancing the grid wouldn't affect the householder.

From Andrew Nicolson,
Bradford on Avon, Wiltshire, UK

E-bikes deserve a mention in our net-zero future. They broke through at least 10 years ago with the advent of cheaper lithium batteries and novel motors. Their chargers are fitted with standard household plugs. Their embodied and per-kilometre carbon output – and unit price – are a tiny fraction of an electric car's.

In his book *How Bad Are Bananas?*, UK carbon footprint authority Mike Berners-Lee figures an e-bike ride burns less total carbon than a regular bike trip, due to a need for fewer food calories.

From Rolf Schmidt,
North Kessock, Highland, UK

If we take the handling of the covid-19 pandemic as a template for how we get to a net-zero world, we can imagine leaders addressing the emergency belatedly with uncoordinated, chaotic, inhumane and often cynical measures.

The hard problem of consciousness remains

4 September, p 44

From Timothy Mead,
St Keverne, Cornwall, UK

Anil Seth breaking a bottle of champagne over the bow of his attempt to explain the physical processes of consciousness and calling it "the real problem" will not make it so.

The difference between life and consciousness is that when you take life apart, there turns out to be nothing, over and above the processes involved. When you do the same to consciousness, as Seth seeks to do, you are left with… consciousness.

On the debate over new fossil fuel projects

11 September, p 11

From Geoff Harding,
Sydney, Australia

The development of a new coal mine in the UK for coking fuel for steel-making would constitute an embarrassing step in the wrong direction. The possible use of green hydrogen in steel furnaces has been mooted for some time and is soon to be a commercial reality, albeit – as with all new technologies – an initially more expensive one. The use of coke from a new mine will reduce the incentive to develop this considerably cleaner method and the UK will soon be left behind.

From John Ormiston,
Bovingdon, Hertfordshire, UK

The UK may not need a new coal mine or even an oil field, as Mark Peplow's comment makes clear (4 September, p 17), but it may have no option. The Petroleum Act, as amended in 2015, requires the UK to make the maximum profits from fossil fuel deposits in its territory. The Energy Charter Treaty means the UK government can be sued by fossil fuel firms for loss of income.

To boldly go, you may need a little spite

4 September, p 40

From Robert Checchio,
Dunellen, New Jersey, US

While the actions of spiteful people may result in head-shaking disapproval, the need for the assertiveness that might be driven by spite has been explored before. In "The Enemy Within", an episode of *Star Trek*, while beaming up from planet Alpha 177, a transporter accident splits Captain Kirk into two personalities – one meek and indecisive, the other bold and brazen.

A review noted that, although it is important to have goodness for intellect and mercy, it is the evil side that provides decisive action and strength. One can't survive without the other.

Many ways to explain the 10,000 steps target

11 September, p 38

From Bob Ladd, Edinburgh, UK

There is an explanation for how a Japanese marketing gimmick came to be the source of the idea that taking 10,000 steps each day is good for you. It may be that 10,000 is an "easy number to remember", but in most European languages, it is no more so than 8000 or 12,000.

The real reason that 10,000 is easy to remember in Japanese is that its Chinese-influenced number system has a separate word for it (*man*). What's more, the Sino-Japanese words for 10,000 are used to mean "a whole lot" – an indeterminate number. The point is not to take exactly 10,000 steps, but just lots of them.

Perhaps metal pollution affected more than insects

11 September, p 25

From Dave Smith,
Alnwick, Northumberland, UK

I read Coline Monchanin and Mathieu Lihoreau's article on heavy metal pollution affecting insects with great interest.

Our intestinal microbiome is effectively an enclosed bioreactor susceptible to such substances. Lead residue build-up from leaded petrol would have been worst in inner-city areas during the 1960s and 1970s, and it is possible that people experienced microbiome changes at that time.

The microbiome is significantly heritable via vaginal birth and is known to be important for the development of a child. Could this have had an impact on the health of millennials and "Gen Z-ers", who were born to parents who played in such leaded dust when they were themselves children?

Dogs may be masters of mental mapping

21 August, p 22

From James Fenton,
Clachan Seil, Argyll and Bute, UK

The story "Monkeys navigate using mental maps just like us" states that most animals don't possess mental maps of their surroundings. I beg to differ.

We had a dog who had a highly developed mental map of our house and garden: whatever window I threw his ball out of, he would run downstairs and out the door straight to his ball, wherever it landed, even though he couldn't see out of them. Another of our dogs, when out on a walk, always takes what he perceives to be the shortest route rather than following us.

I would have thought that the possession of mental maps is a key characteristic of most animals. ▮

Want to get in touch?
Send letters to letters@newscientist.com; see terms at newscientist.com/letters
Letters sent to New Scientist, Northcliffe House, 2 Derry Street, London W8 5TT will be delayed

Unlock the tax-free cash from your home

Find out how much you could release

GET YOUR FREE EQUITY RELEASE GUIDE

Everything you need to know about releasing tax-free money from your home

From the UK's No.1 Equity Release Advisor

Age Partnership

Request your free copy today and find out more about releasing the money from your home

Whether it's repaying your mortgage so you don't have to worry about making monthly repayments, or just making life more secure for the future, we can help. We have a large team of fully qualified advisors available to speak to you over the phone at a time that suits you. They will provide you with a free, no-obligation quotation where you will find out if equity release is right for you, how it could affect potential inheritance and how your entitlement to means-tested benefits could be affected – both now or in the future.

Equity release may involve a home reversion plan or a lifetime mortgage which is secured against your property. Request your personalised illustration to understand the features and risks.

Equity release requires paying off any existing mortgage. Any money released, plus accrued interest, is to be repaid upon death or moving into long-term care. Only if your case completes would a typical fee of £1,795 be payable.

Call FREE to request your equity release guide

0800 068 4086

or visit agepartnership.co.uk/ns

Age Partnership
The UK's No.1 Equity Release Advisor*

*UK's No.1 based on volume of plans, Touchstone data, 2018 – Q3 2020. Age Partnership Limited is authorised and regulated by the Financial Conduct Authority. FCA registered number 425432. Company registered in England and Wales No. 5265969. Company address: Age Partnership Limited, 2200 Century Way, Thorpe Park, Leeds, LS15 8ZB. VAT registration number 162 9355 92. Correct at time of print.

Or return this coupon to get your FREE guide to equity release to: Freepost Age Partnership

Title: .... Name: ....

Address: ....

Postcode: .... DOB: ....

Tel: .... Email: ....

Are you a homeowner? ☐

By supplying your address you are confirming that you are happy for Age Partnership to contact you via letter and email regarding products and services relevant to your enquiry. Age Partnership will contact you on the telephone number you are providing regarding your enquiry. For more information, please visit www.agepartnership.co.uk/privacy or to request to opt out at any time, email enquiries@agepartnership.com

NewSci0921

Here be sandworms

Denis Villeneuve's overly solemn remake of *Dune* is heavy on action, but light on fun, argues **Davide Abbatescianni**

Film

Dune

In UK cinemas from 22 October

ONE of the most anticipated flicks at this year's Venice International Film Festival, Denis Villeneuve's *Dune* is the first chapter of a new two-part adaptation of Frank Herbert's 1965 novel.

The story begins in AD 10,191 in a universe ruled by an interstellar empire in which noble houses fight to control planetary fiefs.

The Atreides family, led by Duke Leto Atreides (Oscar Isaac) is tasked with administering Arrakis, an inhospitable desert planet abundant in "spice", a mind-altering substance that is crucial for interstellar travel. Neither the planet's previous rulers, the Harkonnens, nor its hardy citizens, the Fremen, are pleased to see them – and mining spice is made treacherous by the presence of gigantic, territorial sandworms.

The first part of the film depicts the transition of power after the family's arrival on Arrakis, and establishes the relationships that the Duke's son Paul (Timothée Chalamet) has with his mother, the mystical Lady Jessica (Rebecca Ferguson), and his two mentors, weapons master Gurney Halleck (Josh Brolin) and swordmaster Duncan Idaho (Jason Momoa).

This set-up is effective: we learn that Paul fears his future as the next Duke, that he dedicates himself to intellectual and physical training and that he can count on his parents who, despite their institutional roles, are generally supportive.

As *Dune* progresses, however, the focus shifts from family drama towards politics and the turbulent relations with the Fremen. This transforms the remaining two-thirds of the film into a dull space opera, where the serious and the overly solemn tone starts to impinge on the excitement and mystery. Meanwhile, the story descends into cliché-filled dialogues about strength, courage and honour, the likes of which are all too common in the sci-fi and superhero genres.

> "Adrenaline-filled scenes and Hans Zimmer's bombastic score make *Dune* a rather tiring experience"

Villeneuve takes spectacular visuals to the next level – the Harkonnens' attack on Arrakis is a prime example, as is the scene in which Idaho manages to dispatch half a dozen enemies with relative ease despite a serious stab wound to the chest.

While the movie is packed with tension, majestic heroism and countless mortal dangers, it is sadly let down by the mediocre quality of the writing and the varying levels of performance among the cast.

Chalamet successfully embodies a young man hesitantly embracing the perils and the responsibilities of adulthood. Stellan Skarsgård brilliantly portrays Baron Vladimir Harkonnen's greed and pure evil, and it is a shame that his character wasn't more present throughout. Ferguson, however, fails to provide the complexity of her tripartite role of wife, mystic and mother. She opts for a strange neutrality of expression that struggles to prompt any particular sympathy or antipathy.

Chani, the Fremen warrior portrayed by Zendaya, is reduced to someone bathed by the setting sun, and who occasionally shows up in Paul's visions. Later, she makes a short, clichéd "tough-girl" appearance, before taking part in one of the most banal endings in the history of sci-fi.

Overall, the adrenaline-filled scenes teamed with Hans Zimmer's omnipresent, bombastic score make the 155-minute viewing time a rather tiring experience. Unfortunately, the visually astonishing cinematography by Greig Fraser, the star-studded cast and the industrial quantities of special effects don't save the day.

Dune fails to deliver the ecological, anti-colonialist spirit of the original novel, nor does it provide an urgent, fresh take that would justify retelling its epic vicissitudes. In short: too much action, not nearly enough heart. ▮

Davide Abbatescianni is a film critic based in Cork, Ireland

CHIABELLA JAMES/WARNER BROS

Inheriting mining rights on Arrakis is a poisoned chalice for Paul (right)

Erupting into life

Weird space volcanoes could tell us a lot about life on Earth and beyond, finds **Gege Li**

Book

Fire and Ice

Natalie Starkey

Bloomsbury

SINCE the dawn of its formation, the surface of Earth has been moulded and reshaped by volcanoes. We know them as fiery, magma-filled peaks spewing lava and billowing clouds of ash. Yet beyond our own planet, volcanoes come in many shapes and sizes, not all of which are hot. Understanding their mysterious ways could provide key clues in the hunt for alien life.

***Fire and Ice*, by science communicator and writer Natalie Starkey, delves into the intriguing topic of volcanoes in space and ponders what they can tell us about different worlds and, indeed, about our own.**

Starkey sets the scene by explaining how Earth's volcanoes can bring about devastating hazards – such as ash clouds extending tens of kilometres into the air and mudflows (known as lahars) that engulf everything in their path. Yet they also lead to the construction or regeneration of terrain, sometimes even forming new islands.

She also provides a fundamental science lesson on why volcanoes exist – they are a way for a planetary body to release the heat stored in its core – as well as how they form, the different types that exist and their various features.

From there, the book forces the reader to rethink what they thought they knew about volcanoes by probing the diverse volcanic lives of planets, moons and asteroids at the furthest reaches of the solar system.

It gets particularly interesting when Starkey links the volcanic events on Earth to those on other worlds, drawing on the findings of space missions and observations to paint a comprehensive picture of what alien volcanoes are doing, such as those on Io, one of Jupiter's moons and the most volcanically active place in the solar system.

NATALIE STARKEY

Volcanic activity destroyed Plymouth in Montserrat, but in space, it could be key to life

As the book's title suggests, in space, volcanoes can be cold as well as hot. Cryovolcanoes, with magma made from ice, are the norm for planets and moons beyond Mars, and, like all volcanoes, can play key roles in shaping their worlds. Cryovolcanoes on Enceladus, one of Saturn's moons, for example, replenish the planet's biggest ring with icy particles and gas. Volcanoes also help us to unravel the history of the solar system, raising the possibility, for example, that Venus might once have contained liquid water.

This is just one way in which uncovering the workings of volcanoes elsewhere in our solar system raises the exciting prospect of life in outer space. The volcanic activity of a planetary body, past or otherwise, indicates the presence of a warm core needed to maintain a magnetic field. This, in turn, would protect any life forms from the sun's radiation. And since "it seems that we can find evidence for volcanoes, whether made of fire or ice, in every corner of the Solar System", writes Starkey, it makes sense to cast our net wide in the search for life.

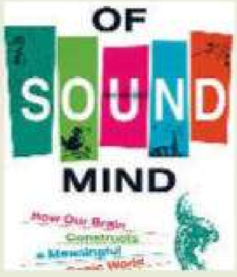
Starkey's background in geology and cosmochemistry perfectly equips her to take us on this journey. She leaves no rock unturned as she boils down everything from how magma forms to plate tectonics, responsible for forming many of Earth's volcanoes, and thought to be unique to Earth. She also covers the weird and wonderful processes that occur on other planets.

Volcanoes aside, it is fascinating to be immersed in the weird and wonderful landscapes of different planets and moons, including those, like Pluto, that were once wrongly written off as being too cold or inert to support any volcanic activity.

***Fire and Ice* is an assured, essential read on everything you could hope to know about volcanoes on both our world and others. It captures the intrigue, mystery and wonder of space, and underscores just how much we have to thank volcanoes for on Earth. ▮**

Gege Li is a writer based in London

Don't miss

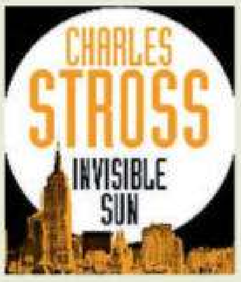


Read

Of Sound Mind by Nina Kraus explains how our brain constructs a meaningful sonic world and shows for the first time that the processing of sound can drive many of the brain's core functions.

Visit

Deciphering at London's New Diorama Theatre takes us to caves in Sulawesi, Indonesia, to decrypt the oldest human graphical marks ever found. This is the last chance to see it, as it runs until 2 October.



Read

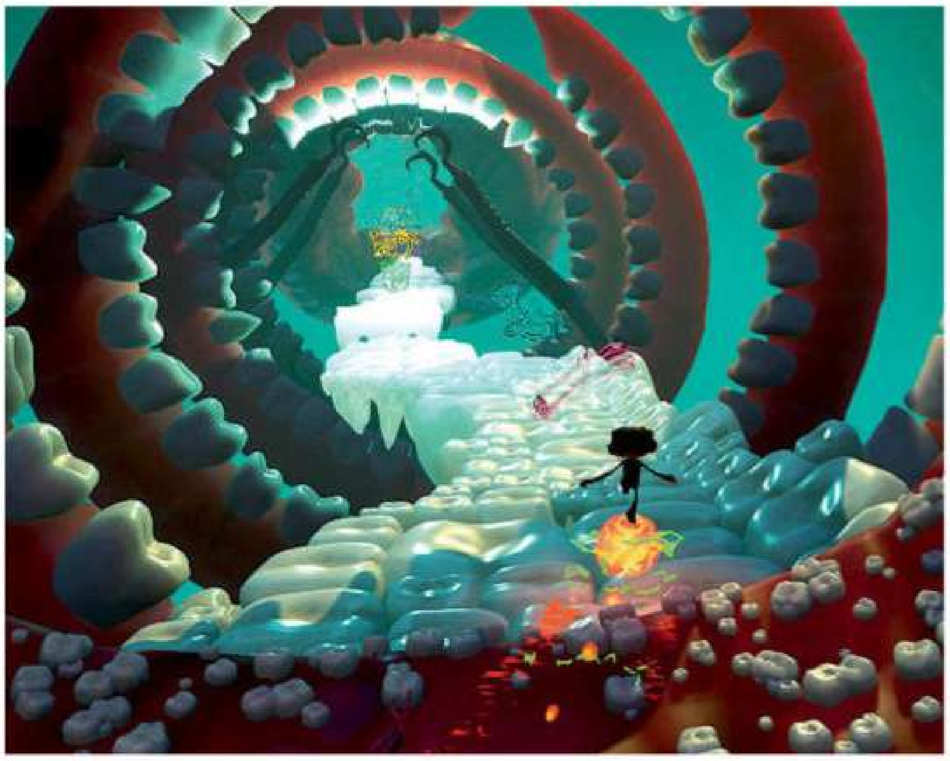
Invisible Sun brings Charles Stross's techno-thriller *Empire Games* trilogy to a head as versions of America in two different timelines begin a conflict that could spell extermination for everyone.

MIDDLE: GUY | SANDERS/KEEPER STUDIO

The games column

Travels of the mind *Psychonauts 2* is a worthy successor to the original game from 15 years ago, with plenty of wit, style and imagination and a more sophisticated take on mental health, says **Jacob Aron**

Jacob Aron is *New Scientist*'s deputy news editor. Follow him on Twitter @jjaron



DOUBLE FINE PRODUCTIONS/IGDB

The darkest corners of the mind are no match for the Psychonauts

Game

Psychonauts 2

Double Fine

PC, PlayStation 4, Xbox One and Series X/S

THESE days, film and TV are full of revivals: continuations of a much-loved story decades later that are a chance to revisit favourite characters when they are older and perhaps wiser. In recent years, I have enjoyed returning to the worlds of *Jurassic Park*, *Twin Peaks* and *Veronica Mars* to name just a few. Of course, there is always the chance that revivals go wrong – the most recent season of *The X-Files* probably should have remained buried in an FBI vault somewhere.

It's this risk that had me holding my breath before beginning *Psychonauts 2*, a sequel to one of my favourite video games of all time. The original *Psychonauts*, a cult classic, came out more than 15 years ago, a gap almost unheard of in an industry that tends to release yearly sequels. Barring a brief virtual-reality spin-off in 2017, I wasn't expecting to see another instalment.

Thankfully, I needn't have worried about this revival. The new game's story picks up just three days after the end of the first one, which saw a young boy called Raz attend a summer camp for individuals with psychic abilities run by the Psychonauts, a kind of psychic spy agency. Here, he learned to dive into people's minds and help them come to terms with their deepest fears.

In *Psychonauts 2*, Raz becomes an intern for the organisation. The structure of the game is much the same – exploring weird and wonderful mindscapes – but its approach to mental health has grown in sophistication. "We're not here to change people's minds, not here to fix people," one of the Psychonauts tells Raz early in the game. "We're here to help people fight their own demons."

> **"The entire game sparkles with wit and creativity, without shying away from serious issues"**

The entire game sparkles with wit and creativity, without shying away from serious issues. For example, one level involves Raz helping someone with a fear of judgement. This manifests in his mind as a bizarre version of *The Great British Bake Off*, in which Raz has to prepare a variety of anthropomorphic ingredients (which are all very cute and extremely enthusiastic about being cooked) before presenting the results to a panel of judges.

Other mindscapes that Raz visits include a mash-up between a hospital and a casino, a city built from bowling lanes and a gigantic mailroom. But my favourite has to be the mind of a brain in a jar, played superbly by Jack Black, who has completely lost his sense of self. You help him rediscover it by reuniting his five senses, represented as band members who are scattered across a *Yellow Submarine*-esque psychedelic land.

The enemies you encounter within these minds all derive from mental health concepts. These include Regrets, which fly about and attempt to weigh you down; Bad Moods, which you have to study to find their source; and Panic Attacks, which frantically scrabble at you in a way that can be overwhelming. It's all thematically fitting and very well thought out.

As a whole, *Psychonauts 2* walks a fine line between exploring trauma and making light of it. The game opens with a thoughtfully worded mental health advisory, warning players that it tackles serious conditions, but usually in a comic manner. It could be a recipe for disaster, but the team succeeds in this balancing act even when events take a much darker turn in the latter half of the game. Even if you haven't played the first instalment, I highly recommend it, as it is one of the best games so far this year. ▮

Jacob also recommends...

Games

Persona 5

Atlus

PlayStation 3 and 4

More travels in other mindscapes. An enjoyable yet lengthy story.

Hellblade: Senua's Sacrifice

Ninja Theory

PC, PlayStation 4, Xbox One and Series X/S, Nintendo Switch

A woman with psychosis battles her way through Norse mythology. Her experience bursts through via incredible audio effects.

WHY IS DUM SO GLUM?

LISTEN how play helped in our brand new Alice in Wonderland audio book.

Find this and more free stories, tools and activities to help all children through life's challenges, big or small, at **gosh.org/play**

GREAT ORMOND STREET HOSPITAL CHARITY

The POWER of PLAY

With thanks to Macmillan Children's Books.
Great Ormond Street Hospital Children's Charity. Reg charity no. 1160024.

JORDI ROS

The great disappearing trick

Black holes eat information – an impossible act that current theories of physics are at a loss to explain, says cosmologist **Paul Davies**

PLAY a movie of an everyday scene backwards and we laugh because it is so preposterous. We can readily distinguish past from future, and only see processes that seem to move from the one to the other. Yet this bald fact of our existence – what we call time's arrow – is, to physicists, a mystery. The laws of physics underpinning the everyday world are symmetric in time. They are reversible, working just as well backwards as forwards.

A new slant on that picture comes from the interior of a black hole. Almost half a century ago, Stephen Hawking made a startling discovery about these monsters, summoned into existence by general relativity, Albert Einstein's theory of gravity. It implied that black holes break the fundamental time symmetry of physics, destroying information and preventing, even theoretically, the reversal of a sequence of events from the future back to the past.

This has become known as the black hole information paradox. It highlights a profound disconnect between general relativity and another great pillar of modern physics, quantum theory, and stands in the way of a long-held dream – a theory that unites the two.

Just recently, there have been claims that the paradox is close to a resolution. Personally, I'm not so sure. But the twists and turns of this long-running saga have always contained surprises, with potentially huge consequences

for our quest to better understand how the world works at the most basic level.

To see the essence of the problem, imagine a box divided in two by a membrane, with oxygen gas on one side and nitrogen on the other. If the membrane is removed, the oxygen and nitrogen diffuse into each other in what seems like an irreversible transition: you couldn't deduce by looking at a uniform mixture of oxygen and nitrogen what its initial state was.

But if, by some magic, we knew every detail of every molecule, we could use the reversible laws of physics to work backwards to this state. At the molecular level, the arrow of time doesn't seem to exist. Physicist John Wheeler, who coined the term "black hole", expressed it in characteristically colourful fashion. "If you ask an atom about the arrow of time, it will laugh in your face," he wrote.

We perceive a macroscopic view of the world in which these molecular details are smeared out. In this picture, developed as part of 19th-century investigations of thermodynamics, time's arrow is a secondary phenomenon. It is dependent on the limitations of our senses, making it apparently subjective.

But then black holes entered the picture. A black hole's defining feature is its event horizon, the boundary inside which gravity is so strong that light cannot escape. As nothing can go faster than light, this means anything crossing the event horizon is irreversibly lost to the outside universe.

At least that is the case on a simple reading of general relativity. This also says that hidden from view in the heart of a black hole is a "singularity", an infinitely warped edge or boundary of space-time where the laws of physics break down. Any matter that hits a singularity – and, crucially, any information encoded in that matter, for example how the molecules in a cloud of gas are distributed – must disappear from space-time.

Evaporating information

This is a challenge to traditional views about time and irreversibility. Compare the fate of an encyclopedia thrown into a black hole with one put into an incinerator. With the incinerator, if you knew the precise state of every molecule and every photon radiated as heat, you could, in principle, "run the movie backwards" and recover the information contained in the encyclopedia. Not so with a black hole. The information loss appears to be absolute and objective: there is no rewind button.

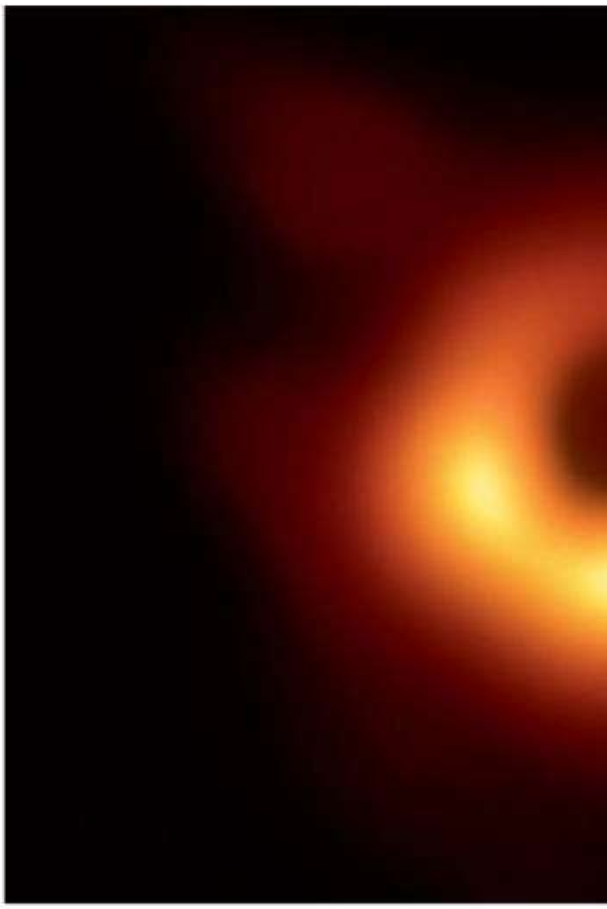
The puzzlement really turned up a notch, however, in early 1974, when Stephen Hawking delivered a famous lecture at what is now the Rutherford Appleton Laboratory near Oxford, UK. I was there. Hawking announced that black holes aren't totally black, but glow faintly, because of the effects of quantum particles that pop up out of the vacuum near its event horizon and are radiated away. The process of emitting "Hawking radiation" slowly sucks energy from the black hole, so it gradually shrinks over an immense length of time.

This was a sensational claim. The Hawking effect was puzzling on several levels, but one question stood out: if a black hole goes on shrinking, does it eventually totally disappear – and if so, what happens to all the stuff that fell into it?

Hawking derived his result by appealing to quantum mechanics. Its laws are time-symmetric, so in theory you should be able to gather all the information encoded in the Hawking radiation and work backwards to the starting state, just as with an incinerated encyclopedia. But Hawking's calculations showed that the radiation produced by a

›

> “God not only plays dice, but sometimes throws them where they can’t be seen”



black hole is precisely “thermal” – entirely random – containing no information whatsoever about what fell into the hole originally.

This is the basis of the black hole information paradox. The laws of quantum mechanics say that information can’t be destroyed. General relativity, by introducing black holes, apparently says it must be.

I first discussed this clash with Hawking in a hotel room in Boston in the 1970s, where we had both travelled for a conference. At that time, Hawking, who was steeped in the general theory of relativity and its predictions about black hole singularities, thought the paradox indicated that quantum mechanics must break down in black holes. He published a paper claiming as much, containing the memorable aphorism – echoing Einstein’s criticism of quantum theory that “God does not play dice” – that “Not only does God play dice, but... he sometimes throws the dice where they cannot be seen.”

Over the subsequent decades, however, many physicists have come to believe that quantum mechanics is sacrosanct, and that the lost information must somehow be returned to the outside universe. That is especially true among string theorists, whose efforts to construct a quantum theory of gravity are rooted in the standard rules of quantum mechanics. After wobbling for years, Hawking finally concurred. What went into the hole, he declared, must come out – in one form or another. But how?

In the absence of a satisfactory theory of quantum gravity, Hawking’s original calculation was, crucially, “semi-classical”. It applied quantum mechanics to fields such as electromagnetism around the black hole, but not to the black hole’s own gravitational field. There is general agreement that such an approximation will break down, and quantum gravity effects must kick in, at the Planck scale of about 10^{-33} cm. This is a number calculated by combining Planck’s constant, which sets the strength of quantum effects, and Newton’s gravitational constant, which determines the strength of gravitation. The hope was that when a black hole shrank to such a size, new effects would emerge to solve the paradox.

But as Don Page, a former postdoctoral collaborator of Hawking’s, pointed out in a major twist back in 1992, we can’t sweep the problem under a Planck-scale carpet. That is because of entanglement, the quantum phenomenon described by Einstein as “spooky action at a distance”. It says that if a pair of particles, for example photons of light, is created from the quantum vacuum, and the particles fly off in opposite directions, they remain intimately linked in their properties. Independent measurements performed simultaneously on the two particles will uncover that link.

Entanglement is a much-studied quantum phenomenon, because it forms the basis for the design of quantum computers. Applied to Hawking radiation, pairs of entangled particles are created near a black hole, with one escaping and the other falling down the hole. Their entanglement implies a subtle residual connection reaching across the event horizon.

In thermodynamics, physicists quantify lost or hidden information in terms of entropy, a general measure of disorder. When information goes down, entropy goes up, and vice versa. Every time a pair of photons is produced and one slips over the event horizon, “entanglement entropy” increases. When the Hawking effect starts out, the entanglement entropy is zero, but it rises steadily as more and more particles get created and separated by the horizon.

LEON NEAL/AFP VIA GETTY IMAGES

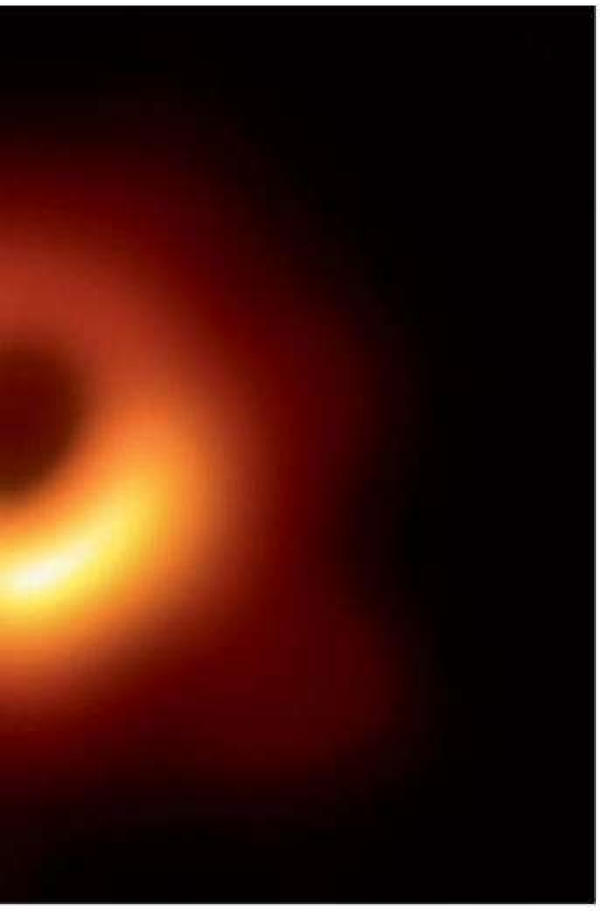
Stephen Hawking’s work laid bare the black hole paradox in the 1970s

Page realised that this inexorable rise must have a limit. As originally suggested by Jacob Bekenstein in 1972, and confirmed by Hawking a couple of years later, a black hole possesses a total entropy proportional to its surface area. As a black hole evaporates, its surface area shrinks, and so does its total entropy. Thus, the entanglement entropy rises and the total entropy falls until, about halfway through the evaporation process, they become equal.

At that point, something changes. Entanglement entropy can no longer go up, but falls with the total entropy as the hole continues to shrink. This loss of entanglement entropy implies the appearance of information. But where? As departures from randomness in the Hawking radiation; that is to say, correlations between particles within it. These correlations grow over time as the black hole shrinks towards its eventual demise. According to Page’s analysis, the original entanglement between pairs of outgoing and ingoing particles reappears as entanglement between outgoing particles – specifically, between particles emitted at earlier times and those emitted at later times. Entanglement in space becomes entanglement in time.

Significantly, the turnover point occurs when the black hole is still a macroscopic, possibly huge object, very far from the Planck size at which quantum gravity can’t be ignored. The build-up of correlations in the outgoing Hawking flux would seem to be a neat way out

New Scientist audio
Articles with a headphones icon are available to listen to via our app **newscientist.com/app**



EHT COLLABORATION

Swirling hot gas marks out the central black hole of galaxy M87, imaged by the Event Horizon Telescope in 2019

of the information paradox. Information in does indeed equal information out, but it is concealed by being spread over time. If this is correct, the reversibility of the laws of physics is preserved by the black hole evaporation process.

That is all well and good, but to buy this argument, you must conclude that there is something missing from Hawking's original calculations, which say there is no entanglement or information in the radiation from the black hole. And there is no agreement on where the flaw might lie. Attempts to provide an answer so far have either appealed to idealised special cases or descended into speculative mathematical backwaters with only a tenuous link to reality. They provide at best circumstantial (and entirely theoretical) evidence that the information about the material that went into the black hole reappears in some guise in the Hawking radiation.

One such idea is that the entanglement between pairs of particles produced near a black hole's event horizon somehow gets erased before one falls down the hole. This entanglement destruction would release a vast amount of energy, resulting in an intensely destructive, incinerating surface known as a firewall encircling the event horizon. This firewall should produce conspicuous effects outside the black hole, but it contradicts a fundamental tenet of general relativity that the event horizon has no special local properties: it just marks the boundary where the strength of the black hole's gravitational field becomes great enough that light cannot escape. The firewall prediction also comes from the questionable practice of considering particles as little packets of localised energy. Direct calculations of the quantum energy density round a black hole, first done in the 1970s, show it to be smoothed out and continuous at the event horizon.

Some theoretical physicists retain the belief that only a fully worked-out theory of quantum gravity will produce a resolution to the paradox. Such a theory will probably include not just intense space-warping effects, but a feature known as topology change. Way back in the 1950s, John Wheeler pointed out that, on the Planck scale, quantum vacuum fluctuations would be so powerful that they would bend space-time into a sort of foamy structure – a frenetically shifting landscape of wormholes and bridges connecting different regions. Wheeler thought that, in place of a point-like singularity at a black hole's centre, there should be a foamy blob. Topology change might also create a type of tunnel or wormhole linking the interior of a black hole with another universe or a distant region of our own universe, an idea first suggested by Wheeler and championed by several others.

Inconvenient truth

If that were the case, you could fall through a black hole and come out in a completely different space. Then there needn't be an information paradox. The information about the infalling matter could simply traverse the wormhole and continue to exist in the other region of space-time. As long as we humans are restricted to "our" space-time region, information is lost, but taking a God's-eye view, information would be conserved.

The possibility that wormholes might connect the interior of black holes with another area of our own space-time outside the hole, allowing information to sneakily leak back out, is the basis of renewed claims recently that the black hole information paradox is close to resolution. But these calculations, as is so often the case, rely on highly idealised analogues of real black holes and involve layers of simplifying assumptions, so it isn't clear how relevant they really are.

There is a more general concern, too, about the uncritical application of quantum mechanics to the black hole evaporation process. Calculations tend to assume that the black hole and its products form an isolated system, which is obviously unrealistic. Quite apart from the disturbing effects of the rest of the universe, there is a fundamental question concerning what we mean by information. For information to be extracted from a quantum system, a measurement has to be performed by an external system. The very act of measurement breaks the time symmetry of quantum mechanics in a process sometimes described as the collapse of the wave function. So if "information" is treated as something that could actually be gleaned from a measurement performed on Hawking radiation, the rewind button is destroyed as soon as that measurement is made.

The black hole information paradox is an inconvenient truth at the heart of physics, yet it has spurred a rich variety of theoretical investigations that have pushed the frontiers of the subject in important new directions. When Hawking announced his black hole evaporation result, it established a link between quantum mechanics, gravitation and thermodynamics. This is surely an important clue, and suggests that the resolution of the paradox – which is undoubtedly out there – lies in a revolution that unites our understanding of all three of those elements. Almost half a century on, however, we are still waiting for that revolution. It might take another Stephen Hawking to start it. ▮

Paul Davies is a physicist at Arizona State University in Tempe. His latest book, *What's Eating the Universe?*, is out now

EARWORMS
DEAD LEGS
HEADACHES
DARK CIRCLES
LOSS OF TASTE
TWITCHY EYELID
INSECT BITES
ACHES
PAINS
SKIN TAGS

ADAM NICKEL

What doesn't kill you… ?

The odd sniffle was nothing to worry about until covid-19 burst our bubble. It is time we paid more attention to minor ailments, says **Graham Lawton**

FOR a few months last year, I broke the habit of a lifetime and started keeping a diary. I hadn't taken a sudden interest in recording my innermost thoughts, I was conducting a scientific-experiment-cum-book-project. I called it my "Mustn't Grumble" diary; every evening, I noted down all of my minor health woes from that day.

Keeping a record confirmed what I had suspected – that I'm constantly slightly ill. Highlights included a cold, a twitchy eyelid that drove me nuts for three days and a terrifying loss of taste and smell. There was also the tedious matter of my chronically sore shoulder and athlete's foot. All in all, I battled dozens of minor ailments.

I hesitate to extrapolate my findings to claim that everyone is a bit ill all the time, but I have yet to come across somebody who isn't. Think about it: when was the last time you enjoyed a day when there was absolutely nothing wrong with you?

And yet there is no formal scientific definition of a minor ailment, and medical understanding of such conditions is often surprisingly rudimentary. This should be a big issue, because about three-quarters of family doctor appointments in the UK are for conditions that rarely require medical intervention, such as back pain, dermatitis, indigestion, coughs and sprains. In the US, about 25 million people a year visit their doctor with common colds.

Even so, the coronavirus pandemic has dragged us back into a world where someone with a sniffle or high temperature can be gravely ill or even dead in a week. It is time for a major re-evaluation of minor ailments.

Obviously, there are occasions when we are properly ill – forced to retreat to our beds or make a doctor's appointment. I'm not talking about that level of illness. I'm referring to the mild, irritating ailments and aches and pains that niggle us on a daily basis: headaches, coughs and sneezes, backache, cuts and bruises, zits, hay fever, heartburn, nosebleeds, constipation, insect bites and the rest. There is a lot that can go slightly wrong. All told, my research into the subject covers more than 100 minor ailments.

The vast majority of our illnesses are trivial, but even though they generally clear up by themselves, they collectively add up to a great deal of human misery. Occasionally, they can even cause serious complications. For some people – for example, those who are immunocompromised – everyday ailments can progress to something worse. Some can be early symptoms of a serious disease.

I would never discourage anyone from going to the doctor, but if we were collectively a bit better at distinguishing genuine minor ailments from the more worrying ones, we would save ourselves a great deal of wasted resources and unnecessary grin-and-bear-it suffering.

Tasteless sandwiches

Most of my woes turned out to be utterly insignificant. But in November 2020, I had a proper scare. I made a sandwich for my lunch and it tasted of… nothing.

I went to the kitchen and opened the fridge. Cheese tasted like chalk; juice was watery. Chilli sauce packed some heat, but had no discernible flavour. I pulled out a beer, but it was only lunchtime, so I sniffed the cat's bowl instead. For once, it failed to make me gag.

Uh-oh. My son had caught covid-19 in his second week at university and the first thing he noticed was a dulled sense of taste followed by a total loss of smell. Around that time, anosmia was starting to be recognised as a common early symptom. (He made a full recovery, but is significantly younger and slimmer than me.)

I will admit that I was scared. Thoughts of hospital, intensive care and even death intruded on my fevered mind. And even if I pulled through what I had by now convinced myself was an unquestionable case of covid-19, there was long covid to worry about.

Many respiratory diseases dull taste and smell due to a build-up of snot, but covid-19's assault on the senses is more insidious. The virus sometimes invades the body via cells in the lining of the nose, leading to inflammation, which causes sensory neurons to malfunction.

I hotfooted it to the nearest walk-in centre ›

The small stuff

Some of the minor ailments I recorded in my diary are very trivial, but still annoying as hell.

TWITCHY EYELID

Most people are plagued by one of these from time to time. They can strike suddenly and for no apparent reason, and disappear just as suddenly after a day or two. Most cases are a harmless condition called myokymia, which for unknown reasons triggers a muscle or group of muscles to quiver involuntarily. It often goes unnoticed, but in the eyelids it causes a maddening twitch, albeit one that is invisible to others. Twitchy eyelids usually clear up spontaneously and can't be treated anyway.

DARK CIRCLES

Quite often when I was burning the midnight oil (and drinking the midnight whisky) to get the book finished, I would look at my reflection the next morning and recoil at the panda-like creature staring back. Dark circles under the eyes are commonly believed to be caused by tiredness and hangovers, but are actually there all the time. The skin around the eyes is thin and anything that makes it pale renders it slightly more translucent than usual. The darkness is actually just the blood vessels and underlying tissues showing through. An early, sober night should sort it out.

BANGED FUNNY BONE

In my shower, there is an annoying bracket that is perfectly positioned for me to clonk my elbow on. Many of my diary entries begin – and sometimes end – with the words "funny bone".

The vulnerable spot isn't in fact a bone at all, but a branch of the nervous system called the ulnar nerve that runs from the spinal cord down the arm. As it passes through the elbow region, it briefly runs near the surface, a part of the anatomy called the cubital tunnel that is relatively unprotected by skin, bone, fat and muscle. If you strike this on a protruding object, it causes the nerve to fire, producing the unique mixture of tingly pain and numbness surging down the lower arm. The natural response is to shake it out while cursing loudly, but there is no evidence that this helps at all.

NECK PAIN

Only a few minor ailments are so irritating that their name has come to mean "annoying". A pain in the neck is among them.

Neck pain is nature's way of reminding you how useful it is to be able to turn your head. There are various causes, though sleeping in a draught isn't one of them, unless the draught causes you to hold your head in a strange and unnatural posture for hours. This is hard to do while awake, but easy during sleep, which is why you can go to bed in perfect neck health and wake up barely able to move. Sprains and strains are another cause. Once the neck is cricked, there isn't much you can do except wait for it to get better of its own accord.

SKIN TAGS

Often mistaken for a type of wart, skin tags are actually just small, squishy, wrinkly blobs of skin. They dangle pendulously from a stalk, not unlike a miniature scrotum. They are totally harmless. What triggers skin tags to grow isn't known, but once one has appeared, it is just as much a part of your body as, say, your leg. Sometimes they fall off, possibly as a result of the stalk becoming twisted and the blood supply being cut off. But mostly they just sit there. Don't attempt to remove them unless you enjoy the sight of blood.

and did a test. Sixty anxious (and largely flavourless) hours later, my phone pinged: negative. I was mightily relieved. My taste buds got the memo straight away and roared back to life. It seems probable that my loss of taste was just a common cold.

Man flu

I felt a bit foolish about my covid-19 wobble. I am not given to hypochondria and don't easily crumble in the face of illness.

However, in this day and age, and at my age (51), being slightly worried and vigilant is actually rational and healthy. Not only is catching problems early better than letting them linger, I am also a man, and for us vigilance is doubly important.

The idea of "man flu" isn't entirely without scientific merit. Women generally have stronger immune systems than men by virtue of having two mighty X chromosomes. Men, however, only have one X and one Y, which is smaller and has fewer genes (yes, men are genetic degenerates).

One of the X chromosomes in a female cell is mostly inactivated. But for reasons unknown, a few genes remain active. Some of these are involved in the immune response, including a gene called *TLR7*, which makes a protein that detects viruses. Women, therefore, have a stronger antiviral immune response than men, which may explain why men are known to get sicker and die more often from some viral diseases, including influenza and covid-19.

Armed with this knowledge, I keep the wise words that Spike Milligan famously wanted engraved on his gravestone on the tip of my tongue: I told you I was ill.

Headaches

Another minor aliment that made a regular appearance in my diary is the headache. This is no surprise: according to a 2017 review article in *The American Journal of Medicine*, headaches are the most common complaint in medicine and count as "an almost universal human experience".

However, as with many trivial conditions, scientific understanding of headaches is surprisingly rudimentary.

VITAPIX/GETTY IMAGES

There are 200 types of headache, most of which have no known cause

> **"Women have a stronger antiviral immune response, which may be why men are more likely to get sicker"**

The International Headache Society's *International Classification of Headache Disorders* (ICHD) lists some 200 different types of regular headache, also known as tension-type headaches even though tension isn't a recognised cause. This list doesn't include migraines or a category called trigeminal autonomic cephalalgias, the best-known of which are cluster headaches; these aren't minor illnesses.

The vast majority of headaches have no known cause. By the same token, the ICHD notes that many things that are widely believed to causes headaches don't, including tension, stress, dehydration, bad eyesight, high-pressure weather systems or "brain freeze". Some unfortunate souls get "primary headache associated with sexual activity", a debilitating condition that is mercifully rare, although more common in men.

Even though a headache can feel like it is your brain hurting, it isn't. Brains don't have pain receptors and cannot hurt. Instead, it is pain receptors in the blood vessels, nerves and meningeal membrane surrounding the brain that are doing the complaining, or often the muscles of the face and neck.

Painkillers are pretty effective for common-or-garden headaches. And yet such headaches are still a major cause of sickies and lost productivity. A US study has found that 8 per cent of people had missed days at work or school because of headaches, and nearly half said they were less productive when they had a headache. For the roughly 1 in 20 people with chronic headaches – which means getting one most days – the impacts are even higher.

For those who fear the worst when they have frequent headaches, the good news is that even chronic headaches rarely turn out to be cancer. Brain tumours can cause pain, but only 1 per cent have headache as their only symptom. So rest assured that if your head hurts, yet you are otherwise OK, it almost certainly isn't fatal.

Aches and pains

Alongside endless entries on my sore shoulder, my diary also recorded pain in my knees and ankles. My shoulder is now better, but my elbow has inexplicably decided to flare up in its place. I feel like I am falling apart at the seams.

Which is because I am. My aches and pains are all in my joints, those overworked and damage-prone parts of the body where bone meets bone. Joint pain is extremely common and has multiple causes, some of them horrible (in a word: gout). But most of the time, the problem is just wear and tear.

Back pain is another leading cause of misery and economic losses. About 80 per cent of cases are diagnosed as non-specific and aren't investigated further.

Often they are caused by a myofascial trigger point, commonly called a muscle knot, on the front of the torso, which is somehow transmitting pain signals to the back. This "referred pain" often isn't taken seriously. One study found that 85 per cent of people experience myofascial trigger point pain in their lifetimes and about half of people have an active one on any given day. Yet doctors often don't even consider them when investigating unexplained pain.

Myofascial trigger points are essentially mini muscle cramps caused when small patches of muscle tissue go into a chronic spasm, often due to overuse. They feel like hard or squelchy nodules just under the skin, which are painful to the touch but can often be broken up by fingertip massage. This has led to the belief that they are crystals of lactic acid. They aren't. Massage works by relaxing the cramped-up muscle fibres, which causes the knot – and its pain – to vanish. The relief can be considerable, though often far away from the knot itself. Ironically, if something is hurting, "where does it hurt?" is often the wrong question to ask.

Overall, my Mustn't Grumble diary confirmed what I have long suspected: I am not a well man. I didn't get properly ill, but not a single day went by without there being something small to sweat about.

But I didn't grumble. I have come to believe that our minor ailments deserve our respect and even gratitude. Victorious Roman generals employed slaves to whisper "*Memento mori"* (remember you will die) to them during their open-top chariot parades, to keep them from getting too big for their sandals. This is how I see minor ailments: a nagging reminder that we are mortal, but that it could be worse, and one day it will be.

In the meantime, chin up: we mustn't grumble. After all, what doesn't kill you only makes you stronger. ▮

Graham Lawton is a staff writer at *New Scientist*. His new book, *Mustn't Grumble*, is out next week. To pre-order a copy, go to shop.newscientist.com/mustnt-grumble

Fighting food waste

Mountains of food are squandered in the rich world. It is an environmental catastrophe, but one we know how to beat, says **Marta Zaraska**

I OFTEN feel guilty in the kitchen. The problem isn't my cooking; I live in France and pride myself on my culinary skills. The cause of my guilt is the amount of food I keep throwing away. A pile of leftover pasta, the uneaten salmon from my daughter's plate, some expired tofu discovered at the back of the fridge – in it all goes. It sits there in a heap on top of the plastic packaging in which most of the food came wrapped.

It might be a modest heap in my kitchen bin, but, worldwide, food waste is a problem of supersized proportions. About a third of all produce is lost or wasted, most of it thrown into landfill. As that food rots, it produces vast amounts of greenhouse gases. If food waste were a country, its carbon footprint would almost match that of the US. You might say that instead of cooking our food, we are cooking the planet. No wonder that scientists, campaigners – and plenty of ordinary folk like me – are deeply worried.

I decided to turn to science and ask what we really know about how to make sure less food is squandered. It was eye-opening, to say the least. I have changed the way I shop and eat. My preferences on the way food is packaged have been transformed. I also learned that the food industry is at the beginning of some sweeping technological shifts, which could see food waste become not a problem, but an opportunity.

For most of human history, sustenance has been hard won and not something we would have dreamed of wasting. I grew up in communist Poland. I remember the food shortages people experienced back then and how my mother cried when mice once got into our stock of sugar. Millions of people still live in food poverty. But those in richer parts of the world now have the dubious luxury of being able to waste food.

It is hard to tell exactly how much ends up rotting because most of it isn't tracked. Our best estimate comes from a 2011 report by the UN Food and Agriculture Organization (FAO), which suggested that about 1.3 billion tonnes of food worldwide is lost or wasted each year. That is a third of all produce and recent analysis suggests that, if anything, this is an underestimate.

There are some things I already do to reduce this problem, like composting vegetable peelings. But those actions have limits. To go deeper, I call Erica van Herpen at Wageningen University in the Netherlands, who studies consumer behaviour. One question that has been bothering her for years is why people waste food when nearly all of us say we don't wish to. "You don't want to have food waste, but it's like collateral damage, it happens along the way," she says.

To get at the causes, van Herpen and her colleagues have been collecting fine-grained data on what people buy and throw away, asking them to complete surveys and food diaries and to snap photos of their food refuse. Other groups have gone even further in the name of science. In 2019, Michael von Massow and his colleagues at the University of Guelph, Canada, dug through the bins of 94 families in Ontario to discover what food a typical household throws away. This kind of work has begun to provide us with better answers about what drives household food waste.

Van Herpen's work showed that some of the main culprits are shopping without a list and buying things you don't need. A lack of

FABIO BUONOCORE

cooking skills is also a big one – burning food, for instance, so you have to toss it out. Another is preparing too much, like I did with my daughter's salmon. This means there are simple thing we can all do to help (see "Nine tips for cutting your food waste", page 45).

Other studies have begun to reveal the important and surprising role that packaging can play in averting food waste. These days, many of us are focused on using less plastic. Here in France, there is no shortage of markets where I can pick up meat and vegetables that come with minimal wrapping – perhaps just a little paper – and that seems like a win.

But avoiding plastic wrap entirely can backfire and lead to food going off more quickly, says Helén Williams at Karlstad University in Sweden. In unpublished work, Williams and her colleagues have conducted life-cycle analyses of various food products to compare the climate change impacts of the food itself versus its wrapping. They found that when it comes to lettuce, for instance, buying smaller bags of 30 grams of leaves instead of 65 grams resulted in people throwing out far less. The smaller bags had about 20 per cent more plastic per gram of lettuce, but a lower carbon footprint overall when food waste was accounted for.

Cereal killer

I have experimented with buying cornflakes from a zero-plastic store and transferring them to a jar at home. Unprotected by a vacuum seal, they quickly went stale and I threw them all away. A little waste plastic, it seems, is sometimes a lesser evil than a lot of wasted food.

This is especially true when it comes to foods that take a lot of resources to produce, like meat, eggs and cheese. "Those are very important to protect because otherwise the resources you have put in are lost," says Williams. Of course, if you want to really lower your food-related carbon footprint, you can consider going vegan.

Now we have a better sense of what causes us to throw out food, we are beginning to scale up solutions. These include campaigns such as Love Food Hate Waste, run in the UK by the charity WRAP (Waste and Resources Action Programme). This initiative focuses on raising awareness of food waste and telling people how to reduce their contribution.

We are starting to see that this sort of approach can make a difference. A 2019 review of 17 food waste information campaigns conducted by Christian Reynolds ›

> **“Offering fewer chips with dishes and putting out less sauce cut food waste in the pub by 67 per cent – customers were just as happy”**

at the University of Sheffield, UK, and his team found that, in some cases, food waste was reduced by up to 28 per cent. Van Herpen says they could be more effective still if people are also given proper tools. Even simple things can help, such as recipe books for leftovers or measurement cups that tell you how much rice or pasta to cook for a certain number of people. A fridge thermometer can be handy too. While many people in the UK keep their fridges at about 7°C, the optimal temperature to prevent food going off is below 5°C.

I am beginning to feel like my kitchen will soon be less wasteful. But one place my good intentions are scuppered is when I eat out – and that’s bad news. “Food consumption out of the home is extremely wasteful,” says Viachaslau Filimonau, who studies hospitality management at Bournemouth University, UK. A recent report produced for the UK’s House of Lords showed that hospitality and catering industries in the country were responsible for 1.1 million tonnes of food waste in 2018 out of a total of 9.5 million tonnes. It is a similar proportion on average across the European Union. In restaurants the food is mostly wasted in the kitchen, while in fast food joints it is mostly wasted by consumers.

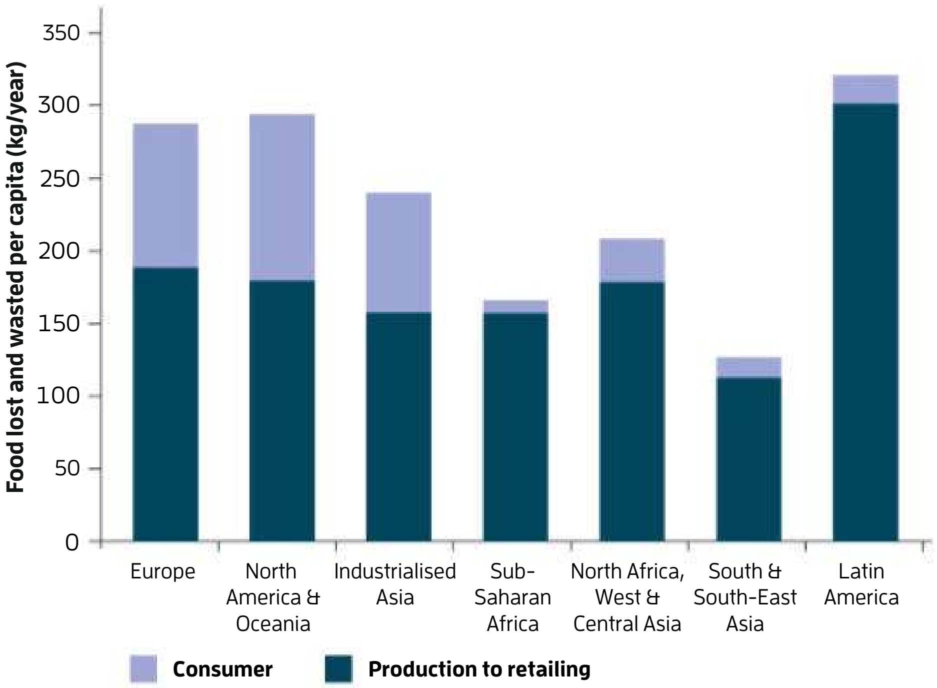
The good news is that Filimonau’s research has shown that up to 79 per cent of that waste is avoidable and the solutions aren’t complicated. The Guardians of Grub, another campaign by WRAP, shares success stories. For instance, when The Ship Inn, a pub in Cumbria, UK, started offering fewer chips with dishes and putting out smaller portions of sauce, food waste was quickly cut by 67 per cent – and customers were just as happy.

All this made me think I ought to eat out less often or at least choose a place that pays attention to waste. But it also got me wondering how consequential my efforts to cut waste at home really are. How does the amount of food waste produced in homes compare against that produced higher up the supply chain?

A major research project called Fusions, coordinated by Toine Timmermans at Wageningen University, found that 53 per cent of food waste across Europe came from households, with the rest generated from a mix of other stages of the supply chain. The picture in low-income nations is less clear. But the 2011 FAO report suggests that in less well-off nations more food is lost during production and less in homes compared with richer countries (see chart, below).

Where does food waste happen?

In countries with higher incomes, a greater proportion of food tends to be wasted at home, while in lower-income countries, most waste happens higher up the supply chain



SOURCE: FOOD AND AGRICULTURE ORGANISATION, 2011

Fighting food waste, then, means action both in households and further up the supply chain. That includes rethinking how we buy and sell food. When I once asked my 8-year-old to pick carrots in a store, she chose the most weirdly shaped ones “because they are so pretty”. But stores don’t tend to stock much misshapen produce because of the perception that consumers, at least adult ones, don’t like it. Several campaigns are now working to change this. The Portuguese cooperative Fruta Feia, or “Ugly Fruit”, buys produce too gnarly for supermarkets and sells it to customers attracted to its lower price and to the cooperative’s waste-prevention mission. A similar campaign by the French Intermarché and Auchan stores proved successful too. In one supermarket near Paris, 2 tonnes of ugly fruit was sold in 15 days.

Researchers tend to agree that prevention is our best line of defence. But there will inevitably be times when we just can’t eat what we have bought. The first alternative is called recovery, which applies to food that is still edible. The idea is simple: redistribute it to where it is needed. Food-sharing services do just this and they are becoming more popular. In the UK, a charity called FareShare redistributes surplus food from suppliers such as farms or supermarkets and delivers it to more than 10,500 charities and community groups. On OLIO, a leftover-sharing app, close to 3 million registered users in dozens of countries upload photos of their unwanted food, mark their location and hand over the goods to those who request them. A study by Tamar Makov at Ben-Gurion University of the Negev in Israel and her colleagues showed that OLIO saved 91 tonnes of food worth more than £700,000 over 18 months. “The sharing economy may offer powerful means for improving resource efficiency and reducing food waste,” the researchers wrote.

Nine tips for cutting your food waste

1. Research shows that buying things we don't need is a key cause of food waste. So take a fridge inventory and make a list before you shop.

2. Organise your fridge and store any leftovers in see-through containers to help you keep track of what's in there.

3. Learn to cook with leftovers. Invest in a leftovers cookbook or find some recipes on the Love Food Hate Waste website.

4. Plastic packaging helps protect food and make it last. So don't avoid it at all costs, especially when buying food that spoils easily, like salad items, or food that takes a lot of resources to produce, like meat and dairy products.

5. If you are having a gathering, serve food on proper plates not paper ones. Studies suggest we are more likely to view food as disposable if it is served on paper.

6. Eating out at restaurants tends to be far more wasteful than cooking at home. So cut down on meals out or choose establishments that are mindful of waste.

7. Don't be afraid of bulk buying. It might seem like this would inevitably lead to more waste, but research shows that it forces us to think about good storage options, such as the freezer.

8. Make sure your fridge temperature is set to 5°C or below. In many UK households it is higher, meaning food goes off more quickly.

9. If you have food you really can't use, search for a food-sharing app and try giving it away to others.

SOLSTOCK/GETTY IMAGES

Eating out in restaurants usually produces far more waste than when cooking at home

When food is no longer fit for the table, it can still be recycled. The first step is to collect it. At the moment, that's only beginning to happen. A 2020 report commissioned by the Bio-based Industries Consortium estimated that 13 per cent of household food waste is collected in the UK, slightly behind the EU average of 16 per cent. Food waste collected by local authorities in the UK is either composted or put into an anaerobic digester, where microbes break it down into biofertiliser and gases like methane that are burned to produce electricity. While this still generates carbon emissions, it is carbon that has only recently been removed from the atmosphere by growing crops, making it a relatively benign source of energy. If all the food waste from UK households was to undergo anaerobic digestion, it could save the equivalent of 490,000 tonnes of carbon dioxide per year.

We could wring even more value from spoiled food by recycling it using what is known as a biorefinery. The idea is to use biological processes to not just break down food into a sludgy mess, but to produce valuable chemicals that can then be used as feedstocks to make other things.

Like oil, food is mainly composed of carbon-based molecules, so in theory it can be refined in the same way, although the job is more complex. Biorefineries are mostly at the prototype stage, but a few years ago, the Italian oil and gas company ENI converted one of its refineries to process waste cooking oils and fats instead of crude oil.

The development of biorefineries could be sped up though. Chemical engineer Dionisios Vlachos at the University of Delaware reckons the key is to find ways of converting the waste into higher value chemicals that could be used as feedstocks for a range of industries. For instance, potato peelings can be converted into HMF, a versatile biochemical that can be used to make textiles, cosmetics and packaging materials. Overall, Vlachos has found that a tonne of potato peelings could be transformed into a range of chemicals worth more than $6000 in total. Federico Battista at the University of Verona in Italy and his colleagues looked at coffee grounds and demonstrated how these could be converted into several valuable chemicals, including biodegradable polyesters that can be made into shoes, backpacks, ropes or even those tiny beads you can find in certain body scrubs.

Having biorefineries produce more profitable chemicals could prove a beneficial way of dealing with food waste in future. But for this to really take off, a few other things are needed, like better collections of waste in bulk and maybe the introduction of carbon taxes, to make the technique more competitive.

Meanwhile, there are encouraging signs that food waste may already be edging downwards in some places. In 2018, consumers in the UK wasted 6.6 million tonnes of food, which was a whopping 18 per cent less than in 2007. In terms of avoided emissions, that is like taking 2.1 million petrol cars off the road. Some of the savings were almost certainly due to higher food prices, but better consumer awareness probably helped.

Then there is the pandemic. One silver lining is that it seems to have made us waste less food. Stuck at home and unable to eat out even if I wanted to, I certainly found I was more careful with the contents of my cupboards. I did a lot of bulk buying, but managed my hauls deliberately, and cooked with leftovers. Surveys have shown that it isn't just me: people in Spain, the Netherlands and the UK all seem to have wasted less food during lockdowns. Let's just hope it's a habit that sticks. ▮

Marta Zaraska is a science journalist based in France. Her latest book is *Growing Young: How friendship, optimism and kindness can help you live to 100*

MicroBioSensor
Rapid diagnostics for improved patient care

Quality Management & Regulatory Affairs Manager

Microbiosensor is a medical device company developing point-of-care IVDs for diagnosing microbial infections. The company will launch an IVD designed for renal dialysis patients in Q1 2022.

Essential Experience / Skills

Microbiosensor is looking to recruit a Regulatory Affairs (RA) manager to help maintain and develop our quality management system (QMS), compile technical files and prepare documentation for regulatory authorities.
We are looking for a self-motivated and goal-oriented individual who will help coordinate regulatory activity for Microbiosensor's first product launch. The successful candidate must be comfortable in an SME-environment and the freedoms and responsibilities of working within a small, dedicated team.

The post is available immediately and full/part-time/flexible working is available. Salary £55-60k (plus share options).

Please send a CV with covering letter (including two referees) to: jobs@microbiosensor.com. Deadline: 26th September.

Essential Experience / Skills

- Experience of ISO13485 and technical file preparation for CE-mark submission.
- Experience of QMS and RA within the Medical Device/IVD industry.
- Involvement with successful IVD/medical device applications to the MHRA/EMA/FDA.
- A strong scientific and/or engineering background.
- Ability to balance multiple tasks, set priorities and deliver within timelines.
- Excellent communication skills/attention to detail.
- Technical file preparation for FDA 510k submission is desirable.

GRESHAM
COLLEGE

FRANK JACKSON FOUNDATION PROFESSOR OF THE ENVIRONMENT

Applications are invited for the position of the Frank Jackson Foundation Professor of the Environment. Gresham College has been giving free public lectures since 1597; these are both presented in person in London and live-streamed to a global audience. Gresham Professors are outstanding in their fields and superb communicators, able to connect with an audience whose members may not have specialist expertise in the subject, but who will be informed people with a thirst for increased knowledge and understanding.

The Professorship of the Environment, which was founded in 2014, is open to any discipline within the field, covering topics such as environmental science, ecology, botany and zoology, earth sciences, natural hazards and/or environmental management.

The appointment is part-time from 1 August 2022 and normally for three years. Gresham Professors present a series of six one-hour lectures each academic year. They also fully participate in College life, attending the Academic Board, being active in promotion and outreach, attending social events and acting as ambassadors for the College. The post offers excellent opportunities to widen public exposure. The College pays an annual stipend of £8,000 (plus reasonable expenses) and encourages applications from all backgrounds and communities.

Further information is available on the Gresham website at:
https://www.gresham.ac.uk/vacancies/environment

Informal discussion may take place with the Academic Registrar,
Dr M. Clare Loughlin-Chow, Gresham College, Barnard's Inn Hall, Holborn, London EC1N 2HH.
Telephone 020 7831 0575 Email: c.loughlin-chow@gresham.ac.uk

The closing date: 9:30 am **Monday 25 October 2021.** Interviews will be in London on **Monday 22 November 2021.**

Journal of Horticultural Science
& Biotechnology

SENIOR EDITOR

Applications are invited for the post of Senior Editor for The Journal of Horticultural Science and Biotechnology (JHSB)

About the Role

The Trustees for JHSB are seeking to recruit a Senior Editor. We seek a well-established academic with a reputation for excellence in research and communication. The Senior Editor is responsible for the editing and editorial policy of the Journal, managing manuscripts through submission to publication in partnership with staff of the Publishers, Taylor & Francis.

Submitting your Application

Applicants should send by email, a letter of application detailing their qualifications, relevant experience and background equipping them for this post, plus the names and contact details for two referees to Mr Roy Preedy at **roy.preedy@btinternet.com**; JHSB's Secretary/Treasurer. **The closing date for applications is 30th September 2021**. Interviews will be held physically thereafter.

This is a part time post suitably remunerated (£12K pa) in line with the time commitment. A post description and further information are available on request from Mr Roy Preedy.

Prospective candidates wishing to discuss this post are also welcome to contact Professor G R Dixon, Chairman of the Trustees of JHSB at geoffrdixon@gmail.com

Blood Health

Q3 2021

Read more at
www.healthawareness.co.uk
www.healthnews.ie

Flow cytometry: a powerful tool to measure blood cancer burden

Cancer cells differ from normal in their expression of cellular antigens. Flow cytometry enables us to characterise cells, therefore allowing us to differentiate between types of cells.

Dr Paula Fernandez, MD/PhD
President, European Society for Clinical Flow Cytometry (ESCCA)

Cell types differ from each other by the antigens they express. The profile of antigens expressed on a given cell constitutes its immunophenotype and is a constant characteristic by which cells can be divided into different cell lineages (e.g. red blood cell vs white blood cells), maturation stages (mature cells vs precursor cell) or activation states, among other things.

Normal cells look alike, but not cancer cells – they usually show some type of immunophenotypic deviation. These deviations in immunophenotype not only allow for disease classification at diagnosis, but also detection of remaining tumour cells during therapy.

The more, the better

Flow cytometry is a technique used to characterise the immunophenotype of cells. Fluorescently-labelled probes specific for an antigen will bind to cells expressing that specific antigen. The probes will emit light when these cells cross a laser beam – that light is then measured and quantified. Its value is directly related to the number of antigens expressed. The more antigens we can simultaneously test on a single cell, the better we can differentiate between cells, even if the differences in immunophenotype are slight, providing diagnostic tests with specificity. The chance of finding rare cancer cells among normal cells becomes higher the greater the number of cells analysed.

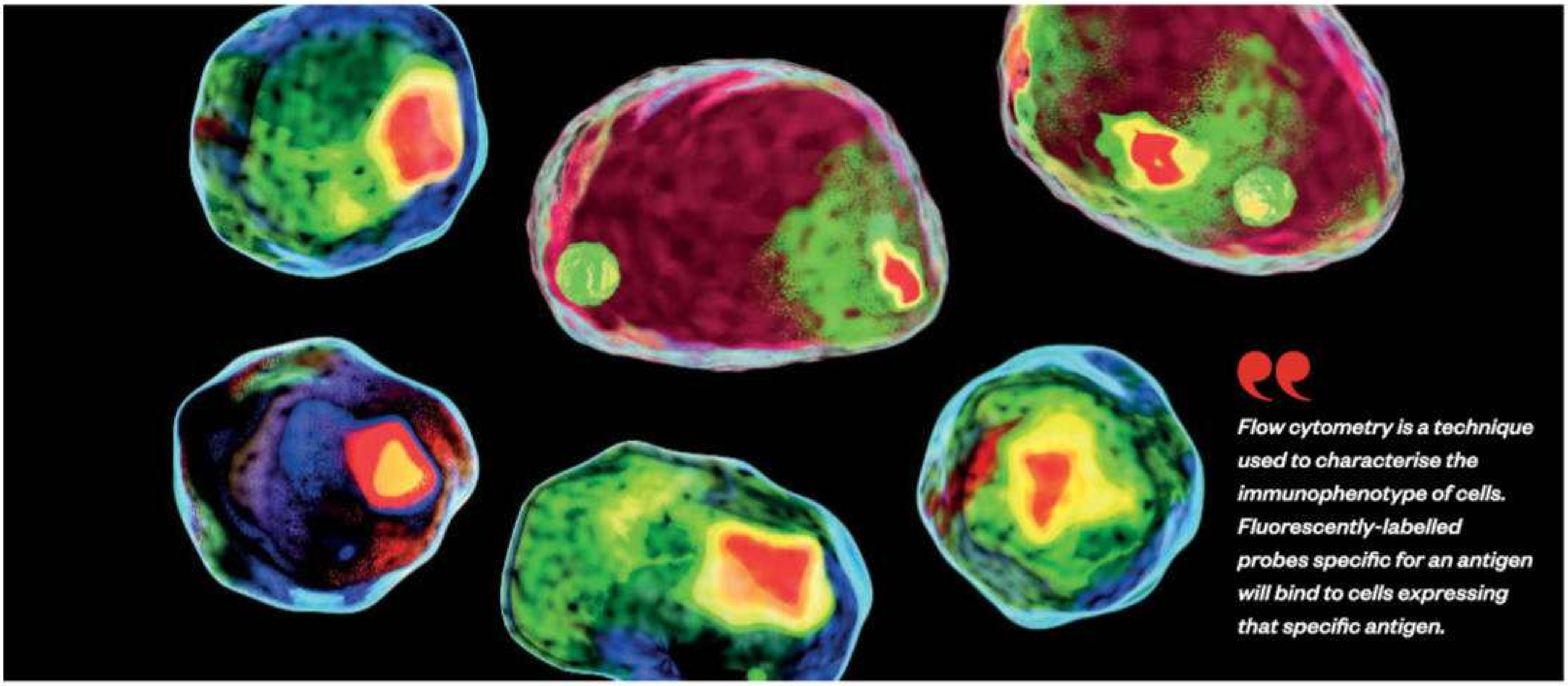
Clinical flow cytometry is a powerful tool that can be exploited to analyse the characteristics of a homogenous cell population in great detail or decipher the composition of a highly complex mixture of cells and any combinations thereof depending on the desired scope of the diagnostic test.

What's next?

The boundaries in the field of clinical flow cytometry are being pushed hard in many different ways. Within a decade, technical progress on the instrument side has increased the number of simultaneously measured parameters by tenfold and greatly increased the speed of measurements to enable the analysis of millions of cells instead of thousands.

The array of reagents has increased to match these new possibilities. New formulations of reagents and their combination into ready-to-use kits have simplified test conditions. Standardised and validated diagnostic techniques have been adopted by many diagnostic labs, leading to an increase in diagnostic quality.

New tests are being devised and validated to monitor new cellular therapies. New tools for handling and interpreting massively increased data sets are being developed and increasingly deployed in our diagnostic routine. In this rapidly evolving field of clinical flow cytometry, the only constant has been change.



> ***Flow cytometry is a technique used to characterise the immunophenotype of cells. Fluorescently-labelled probes specific for an antigen will bind to cells expressing that specific antigen.***

@HealthnewsIE **@MediaplanetUK** Contact information: **uk.info@mediaplanet.com** or **+44 (0) 203 642 0737** **Please recycle**

Head of Ireland: **Ross Bannatyne** *ross.bannatyne@mediaplanet.com* Managing Director: **Alex Williams** Head of Business Development: **Ellie McGregor** Head of Production: **Kirsty Elliott** Designer: **Thomas Kent** Design & Content Assistant: **Aimee Rayment** Digital Manager: **Harvey O'Donnell** Paid Media Manager: **Jonni Asfaha** Social & Web Editor: **Henry Phillips** Digital Assistant: **Carolina Galbraith Duarte** All images supplied by Gettyimages, unless otherwise specified

Rapid lab testing helps diagnose **serious blood disorders**

Serious blood conditions are being diagnosed quicker and more accurately through new standardised laboratory sample testing systems.

Dr. Cornelia Brendel
Head of Diagnostic Laboratories in Hematology-Oncology, University of Marburg

WRITTEN BY
Mark Nicholls

Hi-tech laboratory tests are helping ensure patients with serious blood conditions are diagnosed as promptly as possible.

One of the key techniques is flow cytometry, which rapidly analyses single cells or particles and is used in the diagnosis and follow-up of leukaemia and lymphoma blood cancer.

The approach sees the blood sample, suspended in a reagent for use in the chemical analysis, flow past lasers to give a patient's immune status and help clinicians in the treatment decision-making process.

Improving workflows

New lab systems are constantly being developed that focus on specific disease analysis or conditions and can deliver results quickly to support the treatment of patients.

Automated techniques are also helping make processes more efficient by improving workflows for technicians and ensuring that the repetitive manual movements involved in analysing samples are carried out by machine.

Reduced manual input of the pipetting – dispensing a measured volume of liquid – into the analyser also cuts down errors.

Clinical flow cytometry assays can rapidly characterise normal and aberrant cells rapidly, often providing a result within two hours, ensuring that issues of antigen degradation or retrieval is avoided.

Standardising steps

Manufacturer Beckman Coulter's ClearLLab 10 System is specifically designed for analysis of leukaemia and lymphoma samples, as well as other haematological malignancies.

The in-vitro diagnostic test system features a pre-formulated antibody panel and within it, the workflow is reduced to four standardised steps of sample processing, sample acquisition, reporting and validation.

Lab specialist Dr Cornelia Brendel from the University of Marberg in Germany underlines the importance of keeping pre-analytic conditions and procedures simple and constant in the process.

"By maintaining little variance in reagents, staining protocols and analysis procedures, we ensure reliability of the diagnostic platform so that we can discern even subtle true biologic variations in patient samples," she says.

Dry reagent

The system – which features 10 colour panels - uses dry reagent technology, rather than liquid, which is easier to handle and can be kept at room temperature.

She also notes that this makes the sample staining more fail-safe with less hands-on time, enabling higher sample throughput.

Whilst still adapting to the system – which is CE marked and it will be compliant with the new European IVDR regulations, which are due to come into force next year - she says it is already showing benefits in her laboratory.

"Technicians like the simplified staining procedures and results appear more trustworthy," she says. "Sample preparation is simple and fast and pipetting errors are ruled out, making the data more reliable."

> **"** ***Clinical flow cytometry assays can rapidly characterise normal and aberrant cells rapidly, often providing a result within two hours.***

Standardised procedures

Dr Brendel says that using the standardised procedures can help synchronise and harmonise flow of cytometric data interpretation between different laboratories or university centres.

"Consented panel optimisation could be translated into constant off-the-shelf reagents," she adds. "With focus on support by artificial intelligences in the near future standardisation will become even more important."

She believes these systems can change the work of laboratory medicine professionals, reduce complexity of staining procedures for laboratory technicians and make training and education more straightforward.

The ClearLLab 10 B cell tube and T cell tube are currently under evaluation in her laboratory but both tubes provide a comprehensive multicolour panel useful to diagnose lymphomas.

She added that the ClearLLab 10C panels match the 2006 Bethesda international consensus recommendations for optimal reagents for immunophenotyping of haematolymphoid diseases.

The ClearLLab 10C System
A simple and powerful solution to expedite and standardize your lab´s Leukemia and Lymphoma* workflow.

*Non-Hodgkin Lymphoma only.

BECKMAN COULTER
Life Sciences

LEARN MORE

How laboratories can benefit from **off-the-shelf flow cytometry testing**

Off-the-shelf antibody testing has revolutionised flow cytometry testing in the haematology laboratory.

Dr Véronique Saada
PharmSOiD, Specialist in Hematology, Institut Gustave Roussy, Paris, France

Off-the-shelf flow cytometry testing can enable smaller haematology laboratories to maximise their workforce capacity, save time and money, and achieve faster, more detailed and more accurate immunophenotyping for their clients. It is also a powerful tool used in immunophenotyping for haematological malignancies, such as chronic lymphocytic leukaemia (CLL), as well as in basic research and in clinical trials.

Flow cytometry is said to have several advantages over immunohistochemistry (IHC) in cancer including: the ability to define distinct cell populations by their size and granularity; the capacity to gate out dead cells detection of weakly expressed surface antigens; and multi-colour analysis to measure several antigens simultaneously. At the heart of the test is a panel of antibodies that detect markers or antigens on the cells, aiding laboratorians in the identification of cell lineage.

Fulfilling potential return on investment

Although widely used, to date, flow cytometry testing has not fulfilled its potential to provide laboratories with maximum return on the high capital cost associated with the purchase of a flow cytometer: methodology and data interpretation, clinical data sharing and education have all been hindered by the complexity and variability of test set-up and results analysis.

For manually prepared and designed panels, each of the required number of antibodies must be titrated and validated and then revalidated when combined with other antibodies– a process which itself may require further technical adjustment in order to achieve accurate results. Quality assurance of the reagent cocktail demands rigorous documentation (dating, etc) at each step, including regular, ongoing testing to assess the quality of each batch. Lot variations, as well as stability issues, converge to add to the administrative burden. Manual antibody cocktail preparation is a process that is inherently fraught with the potential for errors.

Dr Veronique Saada is a specialist practitioner in hematology at leading cancer research centre, the Institut Gustave Roussy in Paris. She says: "There can be missing markers and the wrong antibodies can be added, raising the spectre of potential misinterpretation of the patient sample and an incorrect clinical conclusion that can have serious consequences for the patient."

In words that will resonate with lab technicians throughout the world, Dr Saada says: "Cocktail preparation is a complex, time consuming process involving individual pipetting of antibodies into the batch."

Technological development to detect cancers

Since June 2017, labs have benefited from US Food and Drug Administration authorised technology, designed to detect a range of leukaemias and lymphomas, including chronic leukaemia, acute leukaemia, non-Hodgkin lymphoma, myeloma, myelodysplastic syndrome (MDS) and myeloproliferative neoplasms (MPN).

The new technology, Beckman Coulter ClearLLab Reagents, have been authorised through the de novo premarket review pathway, a regulatory pathway for novel, low- to moderate- risk devices that are not substantially equivalent to an already marketed device. The authorisation was supported by a study designed to demonstrate the test's performance, which was conducted on 279 samples at four independent clinical sites.

Lower costs, less time and greater patient and professional satisfaction

For labs around the world, the availability of FDA and Bethesda International Consensus recommendations compliant panels, containing premixed and optimised multi-colour antibodies assay, has important implications.

Like many other ideas that are intended to improve existing products or procedures, the new European IVD Regulation (IVD-R) 2017/746 road is paved with good intentions. However, some of these intentions may potentially render the daily life of clinical flow cytometry laboratories more complex than what they are now, due to the impact these latest regulations will have for laboratory-developed tests (LDTs).

As an organisation, Beckman Coulter Life Sciences continues to devote time and resources to ensure their extensive CE-IVD portfolio of single colour reagents and off-the-shelf testing remains compliant and meets the higher safety and performance requirements outlined in the new EU Regulation,

To download the free ClearLLab e-Casebook and receive copies of the data files please scan the QR code below:

Spread paid for by **Beckman Coulter**

Dr. Nina Orfali, MB PhD FRCPath
Consultant Haematologist, St. James Hospital, Dublin, Ireland and Haematology Association of Ireland Member

Increased demand for transplant in AML

Despite predictions that targeted drug therapies would supersede the need for stem cell transplantation in acute myeloid leukaemia (AML), the demand for transplant across Europe continues to rise.

The last decade has brought about remarkable developments in our understanding of acute myeloid leukaemia (AML), a group of malignancies characterised by the accumulation of immature blood cells in the bone marrow and peripheral bloodstream.

In 2008, tumour DNA from a patient with AML became the first cancer genome to be fully characterised. We have since been steadily learning more about the genetic mutations that drive this condition. Today, with modern sequencing technology, almost every patient diagnosed has access to the molecular profiling of leukaemia-associated genes to guide a personalised prognosis.

However, rather than providing a shortcut to cure, the breadth of genetic data available has highlighted the extraordinary complexity of AML. A plethora of mutations occur in varying combinations from patient to patient and even within an individual patient, sub-populations of leukaemia cells carrying different mutations can co-exist. In truth, no two cases of AML are the same.

Allogeneic stem cell transplantation

While 'good-risk' AML may be cured with chemotherapy alone, for those with high-risk disease, allogeneic (donor) haematopoietic stem cell transplantation offers the only shot at long-term survival. Transplantation harnesses the power of a donor-derived immune system to recognise leukaemia cells as foreign and eradicate them – a so-called 'graft versus leukaemia' effect. The procedure carries with it inherent risks, but roughly 50% of all transplanted patients are alive five years later.

Increasing demand for transplantation

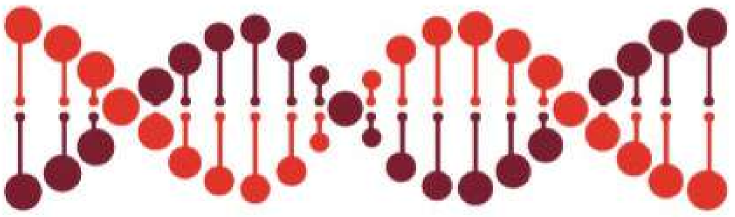
With genetic testing, the proportion of AML patients classified as having high-risk disease is increasing. We are also seeing more cases that have evolved from underlying bone marrow disorders or that arise in patients who have been exposed to chemo- or radiotherapy for prior cancer diagnoses. These cases tend to behave aggressively and are seldom cured without transplantation.

Novel therapeutic agents are helping more patients with high-risk, relapsed or refractory disease to achieve treatment responses that enable them to proceed to transplantation.

> **“** *With genetic testing, the proportion of AML patients classified as having high-risk disease is increasing.*

The lack of a fully immunogenetically-matched donor has traditionally proven a major obstacle to transplantation. With alternative transplant approaches, 'haplo-identical' (half-matched) family members or umbilical cord blood can be successfully used as a stem cell source, meaning a donor will be available for the majority in need.

Older patients have the highest incidence of AML and yet the poorest outcomes. Age has long been perceived as a barrier to transplantation but with reduced-intensity strategies and improved supportive care, curative transplants are increasingly being offered to fit older patients.



Exercising extreme caution at the cost of human interaction

As COVID-19 almost overwhelmed the capacity of our NHS, people were reluctant to bring their health issues to medical attention. However, acute leukaemia rapidly becomes hard to ignore, so our service did not see any slowdown in activity.

Adele Fielding
President, British Society of Haematology

Hardly anyone suspects they have acute leukaemia. Symptoms often include fatigue, breathlessness, fever, aching bones and lingering infections, so it's easy to see why so many people diagnosed by University College London Hospital's leukaemia service last year thought they probably had COVID-19. Indeed, some had both.

Adapting in-patient treatments

None of us had experience of protecting people from infection with a newly emerged virus during a global pandemic. Leukaemia had already suppressed our patients' immune systems, but they needed immediate, intensive in-patient chemotherapy treatments, which would make them even more vulnerable to infection.

At first, separating non-infected patients and staff from those with COVID-19 was not straightforward. There was limited capacity for COVID testing and the correct personal protective equipment for staff took time to define. The cosy rooms into which doctors and nurses crowded to write patient notes and take breaks were now terrifying.

The cost of keeping people safe

As reality dawned that many patients were going to die of COVID-19, it crossed our minds that we could be among them. Many of our team became infected. I am haunted that I could not hug my nurse friends when I met them, ashen-faced and tearful, outside the hospital after one of our departmental nursing colleagues, a mother of two young children, had just died of COVID. We all exercised extreme caution, at the expense of what we had previously considered humanity.

The same limitations on personal contact were imposed on our patients. Once admitted, they were not allowed out of their single rooms and could not receive visitors—this felt like a cruel and unusual additional punishment to a diagnosis of leukaemia. Ward rounds incorporated frantic loved ones electronically, wherever possible, but FaceTimes and empathy were muted by masks and visors.

Remaining vigilant

One year on, my hospital has offered vaccinations to all staff, who are also regularly COVID-tested. Our vulnerable patients with leukaemia have been vaccinated too, but many will not get adequate protection because of their condition or treatment. They can now get a visitor once per week, but mostly they are dependent on the staff for comfort and support when they are afraid. Most of what we do to help people still feels much less human than it was.

I imagine it's no surprise to readers that I remain the person in the supermarket queue reminding you to pull your mask over your nose.

The back pages

Puzzles
Try our crossword, quick quiz and logic puzzle p53

***Almost* the last word**
Does talking or singing to plants help them grow? p54

Tom Gauld for *New Scientist*
A cartoonist's take on the world p55

Feedback
Unusual units, from Sydney Harbour to hippopotami p56

Twisteddoodles for *New Scientist*
Picturing the lighter side of life p56

The science of cooking

Beer cooler cuisine

Cooking sous vide is the route to culinary perfection, and it doesn't have to involve fancy gadgets. **Sam Wong** explains how

Sam Wong is social media editor and self-appointed chief gourmand at *New Scientist*. Follow him @samwong1

What you need

A beer cooler box
Freezer bags
A thermometer
Steak or chicken breasts

SHUTTERSTOCK/BIGACIS

TO CREATE perfectly cooked food, you need precise control over its temperature. It is this thinking that led to the invention of the sous vide method, in which food is cooked in a water bath held at a steady temperature. If you like splashing out on gadgets, you can buy the equipment to do this at home, but DIY methods also exist.

Why bother? Suppose you are cooking a thick steak and you want it to be medium rare. How well cooked a steak is largely depends on the maximum temperature the meat reaches, rather than how long it is cooked for. If you put it in a frying pan, heat is conducted from the surface of the steak towards the centre. By the time the middle of the steak is perfectly cooked, the outer parts are overcooked and dry. You end up with a thin layer of pink in the centre of the steak, and a fair bit of grey closer to the edges.

In a water bath, you can set the water at 54°C – the temperature at which a steak becomes medium rare. You seal the meat in a vacuum bag and leave it in the bath for an hour or more, allowing ample time for heat to reach the centre of the meat, but no part of the steak gets any hotter than this. Then all it needs is a quick flash in a frying pan to brown the outsides, but the rest stays mostly pink.

Chicken breasts, which are made dry by traditional cooking methods, are much softer and juicier when cooked at lower temperatures. Although standard food safety guidance says chicken breasts should be cooked to a core temperature of 75°C, the UK Food Standards Agency says pathogens can also be reduced to a safe level if the internal temperature remains at 60°C for 45 minutes.

One way to do this without specialist equipment is to heat up a large pot of water, check the temperature with a thermometer and turn the stove on and off to hold it within a narrow range. This method is fiddly and requires constant attention.

In his book *The Food Lab*, J. Kenji López-Alt recommends using a beer cooler box instead. These are designed to stay cold, but their insulation means they are equally good at staying hot. All you need to do is fill it with water a couple of degrees hotter than your target temperature. A hot tap might be good enough – if not, add boiled water from a kettle.

Sous vide means "under vacuum" in French, but you don't need a vacuum-sealer. You can use a zip-sealed freezer bag; you just need to squeeze out as much air as you can, since air bubbles act as an insulator. This is best done by partially lowering the bag of food into the water, squeezing out the air and sealing the top (while keeping your hands dry to avoid scalding yourself), then placing the bag fully into the water.

Vegetables cook well sous vide, but most need to reach 84°C to break down their tough pectin molecules, which is trickier to achieve in a beer cooler. ▮

The science of cooking appears every four weeks

Next week
Stargazing at home

These articles are posted each week at newscientist.com/maker

New Scientist Subscriber Event

FREE FOR ALL SUBSCRIBERS

ONLINE EVENT

THE SCIENCE OF A HEALTHIER, HAPPIER LIFE

30 Sept 6-7pm BST, 1-2 pm EST and on-demand

To register and submit your questions visit

newscientist.com/septevent

You will need your 8 digit subscriber number which can be found on our customer service and event emails

New Scientist Photography Awards 2021

Final week to vote!

SHORTLIST AND CATEGORY WINNERS ANNOUNCED

The awards celebrated images that illustrate how science and technology affect our lives and the world around us. Take a look at the incredible images and have your chance to vote for the overall winner now.

To find out more visit

newscientist.com/publicvote

OUT NOW!

Modern Epidemics

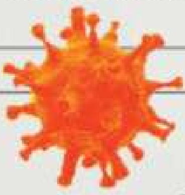
FROM THE SPANISH FLU TO COVID-19

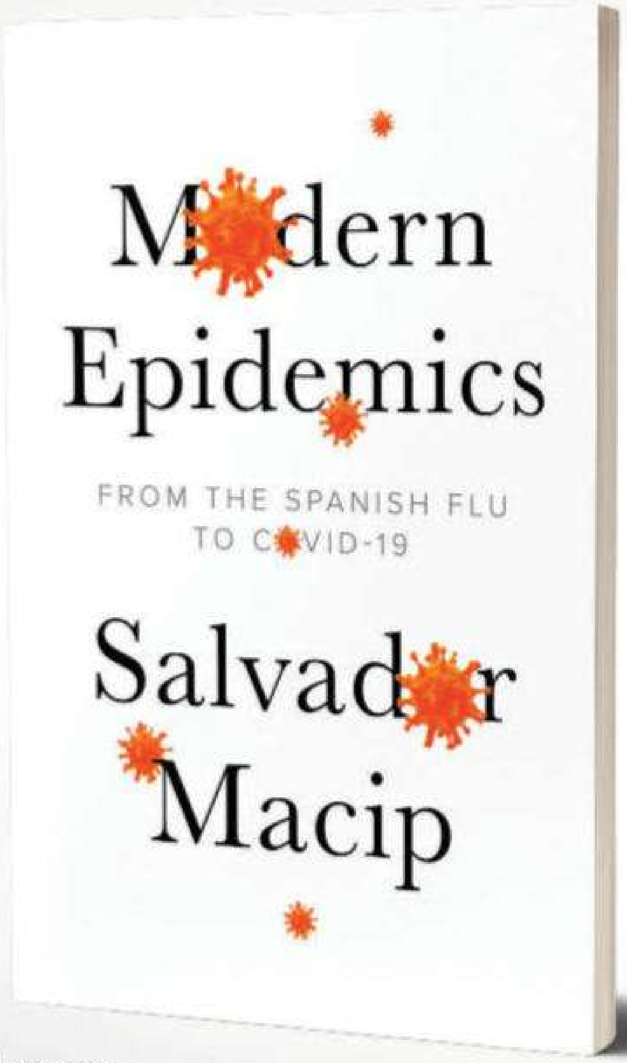
Salvador Macip

"A timely, authoritative and reader-friendly overview of pandemics past and present. This broad and balanced account, which is devoid of Anglo-American bias, provides fascinating insights into the important events associated with, for example, the defeat of the last Inca Emperor Atahualpa, Chagas disease in Bolivia and the Mexican origin of the 2009 influenza pandemic, as well as explaining the latter's malignant effects on our preparedness for COVID-19."

Hugh Pennington, Emeritus Professor of Bacteriology at the University of Aberdeen

Hardback | £14.99 / $19.95

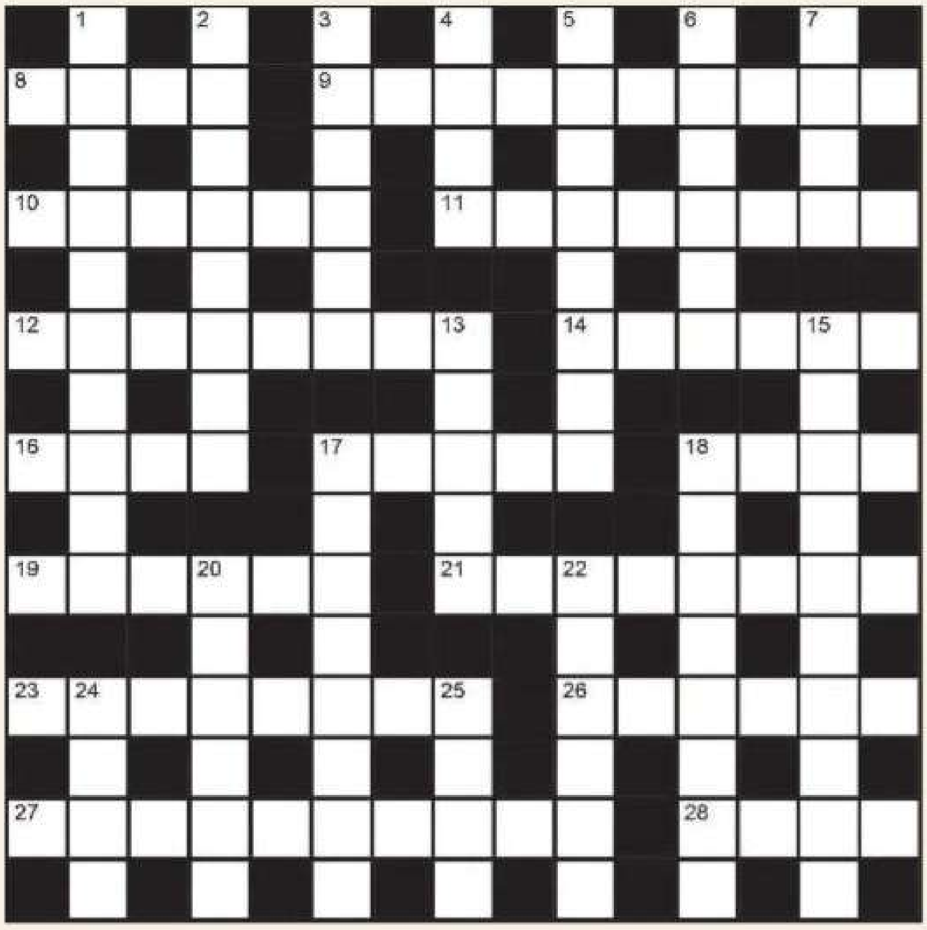




polity institut ramon llull @politybooks facebook.com/politybooks @politybooks

To advertise here please email Ryan.Buczman@mailmetromedia.co.uk or call 020 3615 1151

Quick crossword #92 *Set by Richard Smyth*



Scribble zone

Answers and the next cryptic crossword next week

ACROSS

8 Small lump on the cap of a mushroom (4)
9 Chemist's workplace, perhaps (10)
10 Stitch (6)
11 Signs of disease (8)
12 Long-billed bird, *Scolopax rusticola* (8)
14 Units of distance equal to 25.4 mm (6)
16 (Noise of) explosion (4)
17 Alpha-keratin plates on fingers and toes (5)
18 Dihydroxyphenylalanine (acronym) (4)
19 Heart operation; alternative route (6)
21 Spotted beetle (8)
23 1987 science-fiction adventure starring Matthew Broderick (7,1)
26 Plant in the family Fabaceae – alfalfa or clover, say (6)
27 Sir Robert ___, radar pioneer (6-4)
28 Sicilian volcano (4)

DOWN

1 The study of defence mechanisms against disease (10)
2 Hard form of aluminium oxide (8)
3 Measure of the reflection of solar radiation (6)
4 (Of a tide) recedes (4)
5 Technical glitches; troublemakers (8)
6 Still (6)
7 g (4)
13 Small marine crustaceans (5)
15 Test of a hypothesis (10)
17 Conical front part of an aircraft or rocket (4,4)
18 Cleared of glitches and flaws (8)
20 Tweak (6)
22 Remove; erase (6)
24 Interpret (4)
25 Röntgen radiation (1-3)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #120

1 Which element gets its name from an ancient Greek word meaning "to lie hidden"?

2 In what year was the first recorded circumnavigation of Earth completed?

3 Where would you find the Colombo, Maxwell, Bond and Dawes gaps?

4 Which of the following is an essential amino acid: tryptophan, alanine or asparagine?

5 The Einstein Cross is an example of which astronomical object?

Answers on page 55

Puzzle

set by Brian Hobbs

#132 One of these days

SHUTTERSTOCK/ICONIC BESTIARY

Dear class,

I told you that we would have a quiz next week, and many of you have asked on which day it will be given. An understandable question, so I have helpfully provided the answer below.

A: The quiz will be on Friday, or else Tuesday.
B: The quiz will be on either Monday or Thursday.
C: Either statement B or D is false, but not both.
D: Either the quiz is on Monday or Wednesday, or exactly two of statements A to E are true.
E: Either the quiz is on Tuesday or Thursday, or more than two of statements A to E are false.

Hope that helps.

Your favourite maths teacher,

Mr Gordon

Solution next week

Green tongue

Some people believe that talking or singing to plants helps them to grow better and produce more fruit. Is there any truth in this?

Heidi Appel
University of Toledo, Ohio, US
This is a question that I am often asked because I do research on how plants respond to the vibrations that occur naturally in their environment.

Sound is perceived as vibrations. There is no consistent scientific evidence that talking or singing to plants helps them grow better or produce more fruit. Some studies have shown an effect on plants from music or single tones, some haven't. These studies are rarely done in the same way, making them difficult to compare, so there is no consensus yet.

We know that plants can sense some vibrations that are important to them. Some plants like tomatoes are "buzz pollinated" and only release pollen when the anthers in their flowers experience the wing beat frequency of a pollinator. There is one example of a plant producing more nectar in response to pollinator vibrations.

> "Sometimes I eat plants alive. It would be very troubling if they had an emotional response to this treatment"

My work with Rex Cocroft at the University of Missouri has shown that plants can detect the vibrations caused by caterpillars feeding and they increase their chemical defences in response. There is exciting research ahead in figuring out what plants do and don't sense and respond to in their natural environment.

So, should you play music to, or sing to, your plants? Well, it probably won't hurt them and if it makes you want to take better care of them, why not?

@PhysicsChris*, via Twitter*
Singing helps you enjoy what you are doing, and what you enjoy, you do better.

Markus Eymann
Edmonton, Alberta, Canada
When people talk or sing to their plants, they probably spend more time and pay more attention to the plant than they would otherwise. This helps them to notice when something is wrong, like if they need water, or weeding. I am sure this is why plants appear to do better when people talk or sing to them.

Some people believe that plants respond emotionally to singing or talking. I hope they are wrong, because I routinely rip my plants out of the ground, chop them up, then boil them to death. I eat some of them alive. It would be very troubling if they had an emotional response to this treatment.

@RedKarat73*, via Twitter*
Once I was so connected with my beloved indoor hibiscus plant, and talked to it. It kept growing and blooming. Even friends thought it remarkable. It grew a vine all the way up to my ceiling and then, which way did it turn? Towards my bedroom.

Austin Davis (age 16)
Swadlincote, Derbyshire, UK
Theoretically, when you sing or talk to a plant, you could supply it with more of the carbon dioxide that it uses for photosynthesis. But would this have any impact on the plant's growth? You would have to ask your plant.

DSGPRO/GETTY IMAGES

Do magnetic forces have any effects on the cells of our bodies?

This week's new questions

Right on time **I've been sent an appointment for 11.17 am. Why do I perceive it as being more demanding of punctuality than 11.15 or 11.20, say?** ***Jane Pearn****, Selkirk, Scottish Borders, UK*

Magnetic influence **Do magnets have any effects on human cells?** ***Brian Moss****, Tamworth, Staffordshire, UK*

Want to send us a question or answer?
Email us at lastword@newscientist.com
Questions should be about everyday science phenomena
Full terms and conditions at newscientist.com/lw-terms

New humans

Would it be possible for humans to evolve into two different species in the future?

Francis Blake
London, UK
In order for there to be a genuinely separate species of human – one that could no longer successfully interbreed with *Homo sapiens*, which is a key definition of a separate species – two conditions would need to be met.

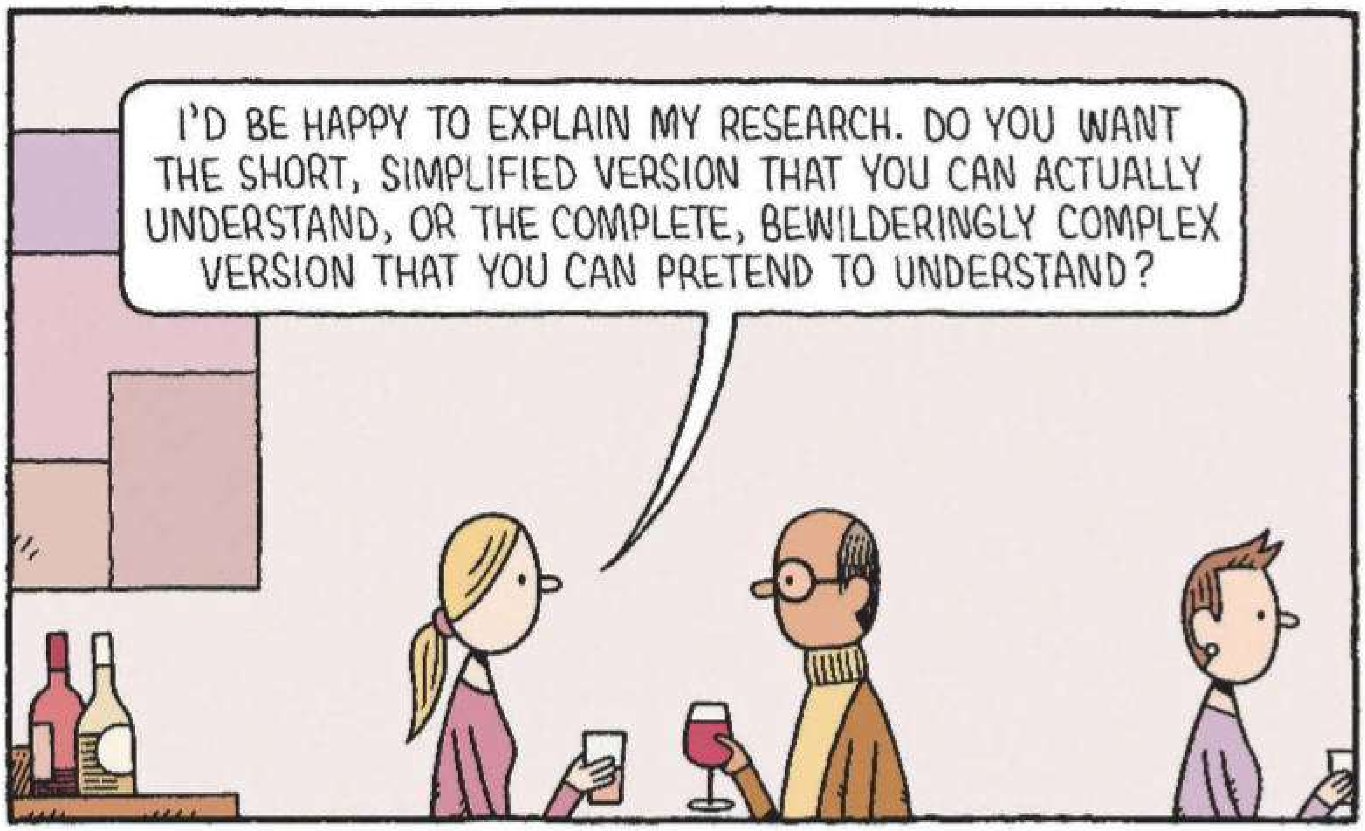
First, a part of the present population of humans would have to be physically isolated from the rest. Second, there would have to be sufficient evolutionary pressure on that isolated community. Then, given enough time, the genetic change in the isolated community might eventually lead to the formation of a new species. However, humans were isolated in Australia for at least 50,000 and possibly as much as 125,000 years, and yet they remained the same species as those in the rest of the world.

Hanno Schmidt
Mainz, Germany
It wouldn't be exceptional to have more than one species of humans on this planet, because this was the case over most of the time of our existence. The last "sympatric" humans we know of were Neanderthals, who became extinct only about 30,000 years ago.

Since stable separation of parts of the species is the key factor for the formation of new species, we can say that a new split of our species is impossible under current circumstances. We are globally connected as never before and this trend is accelerating.

However, we can still play "what if?". The only realistic scenario for the evolution of two species out of ours would probably be if we expanded beyond our home

Tom Gauld
for New Scientist


I'D BE HAPPY TO EXPLAIN MY RESEARCH. DO YOU WANT THE SHORT, SIMPLIFIED VERSION THAT YOU CAN ACTUALLY UNDERSTAND, OR THE COMPLETE, BEWILDERINGLY COMPLEX VERSION THAT YOU CAN PRETEND TO UNDERSTAND?

planet and then lost contact with the settlers. If both populations survived long enough – much more than 100,000 years – we might see divergence and maybe two species of humans.

Mike Follows
Sutton Coldfield, West Midlands, UK
We might get the evolution of new human species if we colonise other planets where people have to adapt to an alien environment.

Mars, for example, is further away from the sun so residents there may evolve bigger eyes to see better in the dimmer light. And without life, Mars is essentially a sterile environment and this may make Martian colonists more susceptible to disease so that mixing with people on Earth is discouraged. This could rule out sex and increase the chance the colonists would develop into a new species.

However, such speciation might happen if we stay on Earth too. If scientists mastered germline therapy, a person's genome could be manipulated. This might bestow an advantage like longer life to the individual and their children. This therapy would probably only be available to wealthier people who might tend to pair up with other "enhanced" individuals, perhaps eventually leading to a new species. This process is started artificially by tinkering with genes, but reinforced and consolidated by cultural differences. This might be in the realms of science fiction at the moment, but it wouldn't be the first time that science fiction became science fact.

> **"The only realistic scenario for the evolution of two species out of ours would be if we expanded into space"**

Herman D'Hondt
Sydney, Australia
Of course it is possible, but I feel strongly that it won't happen.

Homo sapiens split from Neanderthals at least 400,000 years ago, when Neanderthals moved into Europe and Asia, while *H. sapiens* stayed in Africa. Yet, when the two subspecies met again hundreds of thousands of years later, they were still able to interbreed. Even if we could spread to other planets and interstellar travel took thousands of years, this is still a short period compared with the time required for the evolution of new species.

Ben Haller
Ithaca, New York, US
One obstacle is that selection due to environmental differences has largely ceased to operate in humans today. Earlier in our evolutionary history, our survival would have depended on our degree of adaptation to local environmental conditions, but culture and technology have now largely mitigated that.

For an interesting exploration of these ideas, try *The Time Machine* by H. G. Wells. Published in 1895, it is one of the earliest examples of the genre of science fiction, and remains a classic. ▮

Answers

Quick quiz #120
Answers

1 Lanthanum. It is derived from the ancient Greek word *lanthanein*
2 1522
3 Between Saturn's rings
4 Tryptophan
5 A quasar

Cryptic crossword #66 *Answers*

ACROSS 1 Cred, **3** Pangolin, **8** Residue, **10** Index, **11** Mood swings, **14** Uncurl, **15** Munich, **17** Spiral arms, **20** Brown, **21** Nuclide, **22** Rainy day, **23** Ague

DOWN 1 Chromium, **2** Ensconce, **4** Acetic, **5** Going public, **6** Lode, **7** Next, **9** Discrepancy, **12** Piercing, **13** Phosgene, **16** Crania, **18** Uber, **19** Loci

#131 The Paradise Club
Solution

1/18; 18/35.

The total T when adding the scores of two regular dice ranges from 2 to 12. Also, T has the same chance of appearing as 14−T (opposite die faces add up to 7, making 14 for two dice), so 3 and 11 are equally likely, as are 4 and 10 and so on. The only values of T for which both T and 14−T are different primes are 3 and 11. Of the 36 possible combinations of two dice, only two add to 3, so the chance of scoring 3 (or 11) is 2/36 or 1/18.

Let's call Gus's chance of a free drink G. He either wins first go (a 1/18 chance) or he fails and Bart fails, returning us to where we started and his chance is G. So G=1/18+(17/18)×(17/18)G. Solving this gives G=18/35.

Imperial march

For those intent on taking back control and liberating themselves from the straitjacket of always forwards-moving clocks, good news arrives with the UK's intention to allow shops and market stalls to sell goods using solely imperial measurements again following its exit from the European Union.

From a purely nostalgic perspective, Feedback welcomes the prospect of once more being able to buy a fluid scruple of cough medicine or a furlong of elegantly curved banana. But why stop there? Many more recherché measurement units should now make a comeback. The British thermal unit, for example, a measure of heat that sows confusion in the rare contexts where it is still used by having at least six slightly different competing definitions, is overdue a return.

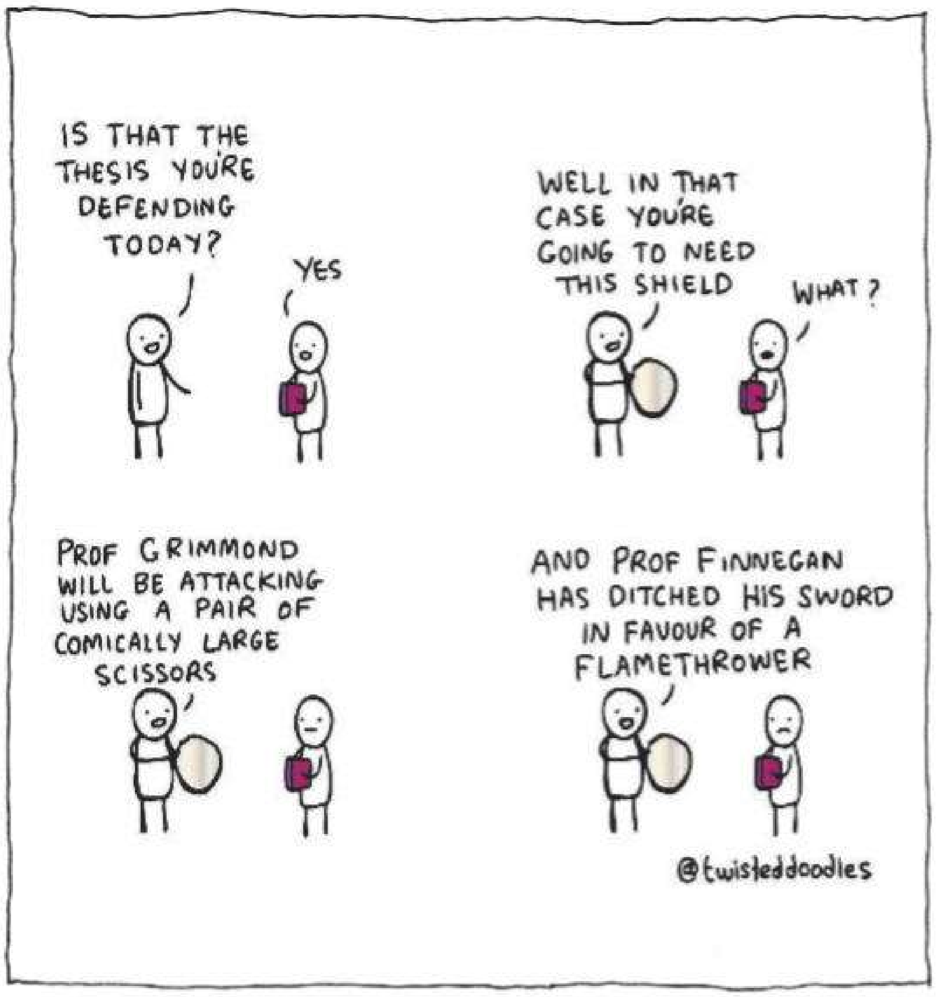
Or might it be time to bring back the UK's predecimal currency? As one Twitter sage remarked, this would be a welcome boost for the STEM sector, "mainly for the huge amount of money you could earn configuring IT to cope with a system no-one else... would touch".

Feedback suggests give and take is in order. For really good measure, and to show a flexible, global, forward-thinking Britain, the UK government should seize the initiative in abandoning nonsensical internationally imposed regulatory norms and decimalise time. That would really fast-forward us to the future as we turn back the clocks.

Safe harbour

Also taking a global perspective on measurement is Mike Clarke from Essex, UK. He takes issue with the Australian use of Sydney Harbour as a unit of volume (4 September), having been there once. "As far as I could see it has no hard bounded limits," he complains, instead consisting of a river complex and very many bay inlets. "It's almost impossible to appreciate or gauge its size let alone its depth as you can't see it all from a single viewpoint."

Twisteddoodles *for New Scientist*


IS THAT THE THESIS YOU'RE DEFENDING TODAY?
YES
WELL IN THAT CASE YOU'RE GOING TO NEED THIS SHIELD
WHAT?
PROF GRIMMOND WILL BE ATTACKING USING A PAIR OF COMICALLY LARGE SCISSORS
AND PROF FINNEGAN HAS DITCHED HIS SWORD IN FAVOUR OF A FLAMETHROWER
@twisteddoodles

Got a story for Feedback?

Send it to feedback@newscientist.com or New Scientist, Northcliffe House, 2 Derry Street, London W8 5TTS

Consideration of items sent in the post will be delayed

Because it has solid, well-defined edges and its entire body of water is visible from the quayside, "surely a better harbour to use as a volumetric unit would be somewhere like Bridlington on the east coast of England", Mike adds.

Be careful what you wish for, Mike. The UK government will be issuing a statutory instrument advocating the Bridharb before you know it, and suggesting Australia adopt it as part of the countries' new trade and defence deals.

Toilet hippos

Meanwhile, Australia's development of idiosyncratic measurement norms continues apace. Very many of you write in linking to ABC's news report on new "flushability" standards intended to prevent fatbergs of congealed oils and wet wipes accumulating in sewage pipes. "Every year 120 tonnes of wipes, the equivalent in weight of 34 hippopotami, is removed from the network" in south-east Queensland, it states.

This statistic speaks of weary experience – it can't be easy to crowbar a hippopotamus from a drain. With Feedback's sources quoting the average weight of a hippo at around 1.5 tonnes, the specimens in the Queensland sewers are clearly big 'uns, too. We suppose they fall in when small and just grow fat on the overabundant nutrients. And possibly pizza. If they have learned the ancient art of ninjitsu from a mutant rat, we shouldn't be at all surprised.

The ones that got away

Many activities were curtailed or had to be abandoned amid the pandemic restrictions introduced in early 2020. But not in one sphere, Feedback learns from a study by Stephen Midway at Louisiana State University and his colleagues, "COVID-19 influences on US recreational angler behavior". Its survey of almost 250,000 anglers in 10 US states reported a slight uptick in fishing trips compared with normal years.

A phrase has, naturally, been coined for this safe, solo, outdoor activity far away from the stresses of pandemic life. Let's hear it for social fishtancing.

Keep it to yourself

A less rosy picture is painted for fans of recreational three-plus-somes by a paper in Feedback's bedtime go-to, *The Canadian Journal of Human Sexuality*. The study by Anabelle Bernard Fournier at the University of Victoria, Canada, and her colleagues is titled "Group sex in the time of COVID: Intimacy, learning, and community-building in sexual communities during a pandemic".

We will leave it as an exercise for the reader to find out how, but their findings follow the discovery by researchers at the University Medical Center Göttingen in Germany that mask wearing boosts self-perceived dry mouth and halitosis. Getting up close and personal again in the after times ain't gonna be easy.

These corvid times

Such squeamishness goes some, but not all, of the way to explaining the sign seen by Katherine Little at the National Trust property of Cotehele in Cornwall, UK, which she sends in response to us unwisely cutting the ribbon recently on a thread on toilet signage (31 July and 28 August).

"Please be kind as we all find our way back to normality," it states. "These toilets are enclosed and can get busy. Face coverings are recommended in crowed areas." They are notoriously intelligent birds, of course. Who knows what they have been plotting while we have been away. ▮

Essential Daily Discoveries

NEWSPAPER OF THE YEAR · JOURNALISM YOU CAN TRUST

65p
The Messi of his day
Dan Walker
Karen Gillan
£1.20
weekend
Travel unlocks for holidays
How No 10 ignored warnings as Delta tore across UK
Games&Puzzles

For a newspaper that's as balanced as it's bold.

Award-winning, no-nonsense, non-partisan journalism.
Just 65p per day Monday to Friday **or try i**weekend
with all you need to ease you into your days off for £1.20.

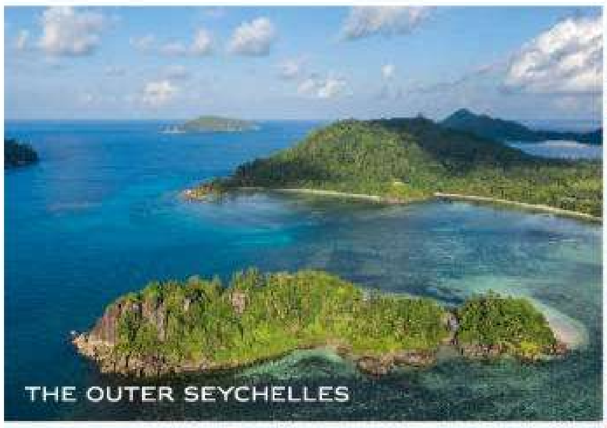
Want to subscribe?

Visit inews.co.uk/subscribe

Or call 0800 082 0628

Get the i digital edition from £4.99 per month. Print & i digital edition subscription from £3.12 per week.

Terms and conditions. The essential package i print & digital editions for £3.12 a week. Direct debit only. We will send you vouchers to be used instead of cash when buying the print edition. Vouchers may be used across the UK. i Digital Edition: Recurring payment of £4.99 payable monthly by Direct Debit minimum term 3 months. Phone lines open 9.30-5 Mon-Fri.


THE OUTER SEYCHELLES

AZORES ARCHIPELAGO, PORTUGAL

FLORIDA GULF COASTLINE, UNITED STATES

SYLVIA EARLE EXPLORES
COCOS ISLAND, COSTA RICA

THERE ARE OVER 130
HOPE SPOTS GLOBALLY

SYLVIA EARLE WITH VOLUNTEERS,
THE OUTER SEYCHELLES

GREAT BARRIER REEF, AUSTRALIA

MOBULA RAYS, AZORES
ARCHIPELAGO, PORTUGAL

SEA LION,
GALAPAGOS,
ECUADOR

ON OUR WATCH

Hope can now be spotted across all our planet's seas and oceans. Sites are made into aquatic havens by local communities, to safeguard the richness and diversity of the ecosystems they depend on. Sylvia Earle's invaluable experience as an explorer and marine biologist continues to help further their goal, through her organisation, Mission Blue. Together, they have created over 130 Hope Spots and counting. Carrying a message of hope for generations to come. It is that vision, that dedication to a perpetual planet, which we are proud to stand by. **For as long as it is needed.**

#Perpetual

OYSTER PERPETUAL SEA-DWELLER

MISSION BLUE

ROLEX SUPPORTS MISSION BLUE
IN ITS COMMITMENT TO PROTECTING
30% OF THE OCEANS BY 2030

ROLEX